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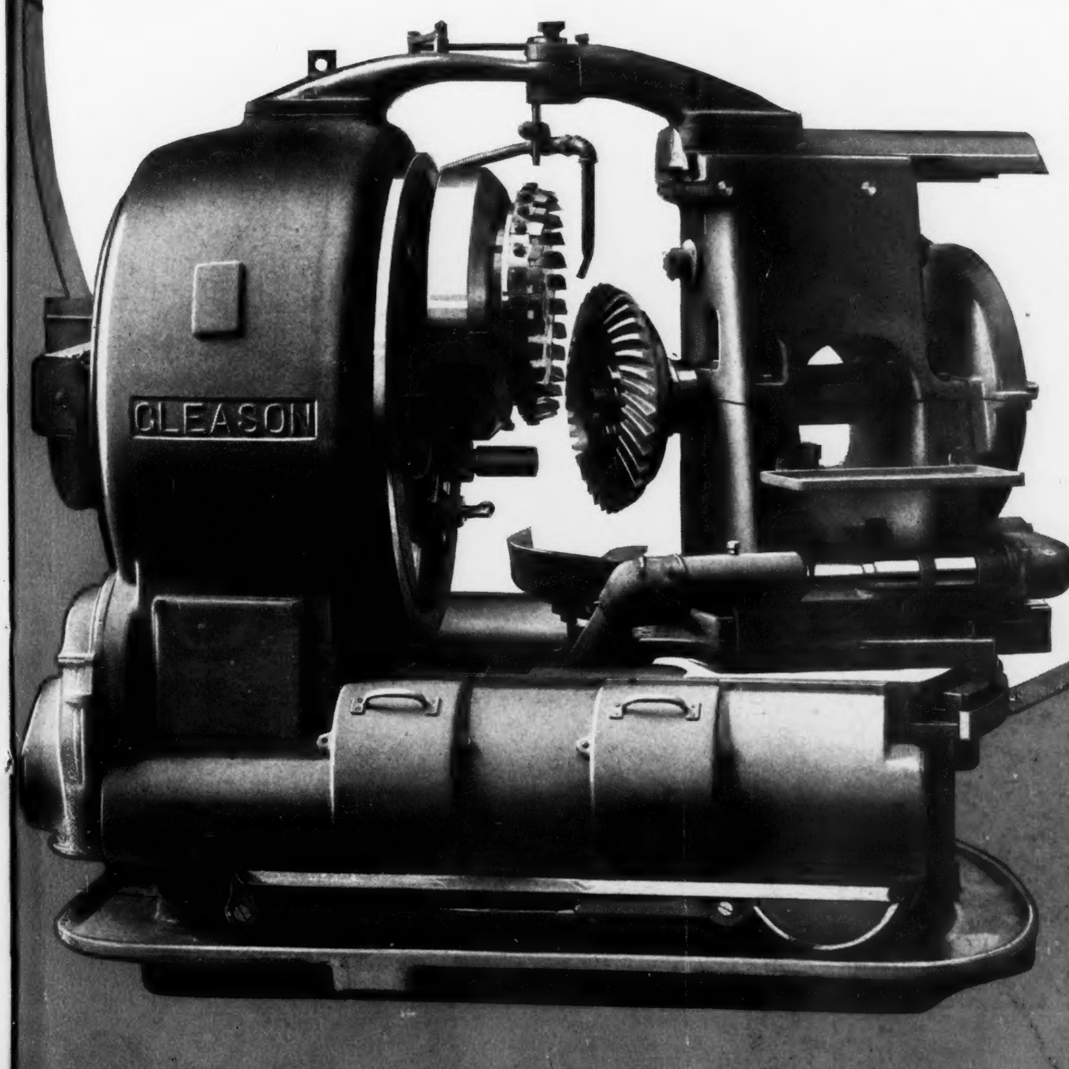

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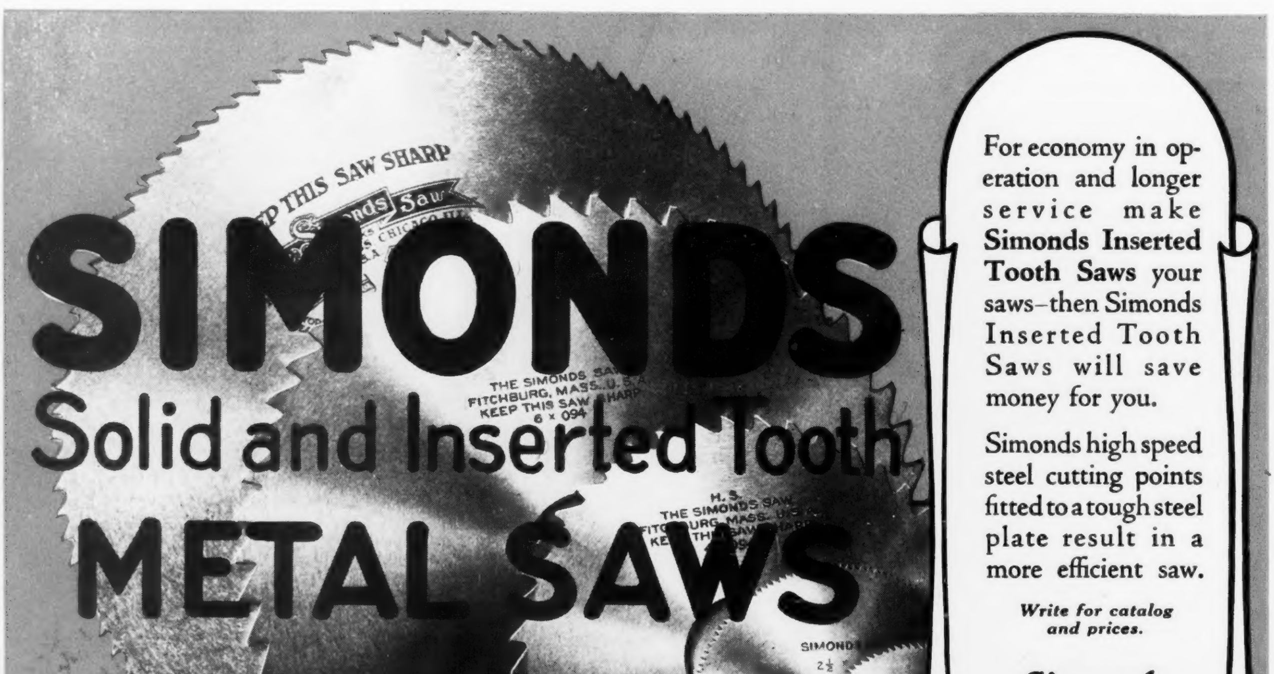


Precision Lapping

Lapping Abrasives and Methods, and the Use of a Double Type of Lap for Plane Parallel Surfaces

By WILLIAM E. HOKE*

LAPPING, as applied in precision tool and gage making, is a direct inheritance from the lapidary, who has long employed this method of cutting and polishing precious stones by means of diamond dust charged or embedded in a copper disk. The ease with which the lapidary found it possible to cut a substance as hard as a diamond paved the way for the handling of hardened steel in the same manner, that is, by having a soft surface in contact with a hard surface, with abrasive material between the two. As in the case of cutting and polishing precious stones, the abrasive material embeds itself into the softer substance, and scores, cuts, and scratches the harder material as the lap is manipulated by the workman.

The lapidary's method has been subjected to several variations. One of these consists in the use of two surfaces of equal hardness, between which non-charging abrasives are utilized. Abrasives of this type include a broad classification in which there are powdered whetstone, Turkish lapping powder, rouge, Vienna lime, and others. A typical use of the non-charging type of abrasive prevails in wearing in a lathe spindle into its bearings where both components are of hardened steel. In this operation, the use of powdered whetstone with oil causes the abrasive to wear equally on the two parts, with the result that one part very quickly wears into the other and produces an accurate fit.

There is still another form of lapping, in which a soft substance is brought into contact with a surface that is harder and tougher, with a non-charging abrasive between. In this case the abrasive material does not embed itself in either substance, but abrades the softer while leaving the harder unchanged. If one surface is extremely tough and another fragile and exceedingly hard, the fragile surface may be lapped away rapidly by the use of a non-charging abrasive of tough quality. An example of this is found in lapping glass. The quickest way of grinding glass is to use a cast-iron plate, steel dust, and a little oil. Take the lapping of a bottle, for instance. By the use of the cast-iron plate, steel dust, and oil, the abrasive crunches its way into the glass and chews up the hard, fragile substance in a surprising manner. By this method glass may be formed much more quickly through the use of steel dust than by the use of emery, producing a matt or "ground glass" surface without the scratches which are caused by emery if it is embedded in the lap.

In lapping or polishing glass with rouge, this non-charging abrasive has an action that is little understood. Rouge has a rapid wearing action which comes from the particles rolling around between the two surfaces, wearing away the harder of the two substances, and giving a high polish. This action will be more fully discussed as we proceed.

Diamond Dust and Method of Grading

First consideration should be given to the charging abrasives. Conspicuous among these is Brazilian bort (commercially known as "diamond dust") which has been used for centuries in polishing diamonds and other substances of great hardness. Commercial diamond dust possesses wonderful properties for the treatment of hardened steel. As purchased, the material must be separated into various grades, according to relative fineness. Until this is done, the abrasive is practically useless for working on hardened steel. The separation is accomplished by placing a little of the material in a test-tube containing kerosene, light oil, benzine, or other liquid. This mixture is then shaken and allowed to stand until the coarser particles settle to the bottom. The upper portion of the liquid, containing the finer particles, is then poured off into another test-tube, and the settling process is allowed to repeat itself, after which the excess liquid is poured out and the abrasive is ready for use. The customary method of using machine oil as the settling liquid is a tedious process, since, in order to get the finest grade, the mixture must be allowed to settle for an hour or more in the first tube, and then again in successive tubes. Sometimes weeks are required to eliminate all but the finer particles. The process can be hastened by the use of a liquid of less specific gravity than machine oil, such as kerosene, benzine, ether, or alcohol. In these lighter liquids, the particles settle very rapidly, and it is possible to accomplish in a few minutes what would take weeks with a heavier liquid.

Diamond dust is usually used either with a cast-iron, machine-steel or copper lap. In the charging operation, it is only necessary to take a few drops of the liquid containing the abrasive, smear it over the lap, and begin working with the hardened steel, flint, glass, or whatever substance is to be cut. The diamond dust immediately embeds itself and the work may proceed. A peculiar characteristic of diamond dust is that the particles always cut a continuous fine line or scratch. By examining the work under a strong magnifying glass it is possible to see the long continuous lines which are produced. These fine scratches form a very brilliant surface not produced by the use of any other abrasive. Because of this characteristic, diamond dust is undoubtedly the best abrasive for work in which it is desired to obtain accuracy of surface and great brilliance, rather than a surface which is highly polished and reflecting. The brilliant surface of the polished diamond is due to the use of diamond dust, which is less hard than the stone itself.

*MAJOR WILLIAM E. HOKE, well known in the mechanical field because of the methods for producing precision measuring means of the highest type that he developed during the war period, worked in his boyhood in the shop of his father, Joseph W. Hoke, inventor of the chalk-plate process for illustrating newspapers. He never served an apprenticeship nor attended a school of technology, his mechanical education having been obtained entirely through the study of engineering and technical journals and books. In connection with his father's business in St. Louis, he built up his own laboratory and machine shop, and became known as one to whom other shops turned over their precision work. Major Hoke early became interested in fine precision lapping of hardened steel, and during the war he developed methods for producing the precision measuring blocks known as the Hoke gages. He offered his development to the government as a war emergency contribution, and became a Major in the Ordnance Corps, stationed at the Bureau of Standards. At the present time he is engaged in developing other precision gages, such as precision cylinders, spheres, angles, etc. Major Hoke is unmarried and lives in Baltimore.

The hardest of all abrasives is black diamond powder. This substance is very similar in appearance to diamond dust, and is really much like that abrasive, but possesses far greater hardness. In fact, the black diamond is the hardest known substance. It is so much harder than the diamond crystal—the jewel—that the use of black diamond dust in polishing the precious stone would produce a rough and scratched surface. The black diamond is used in saws and cutting tools, set in the edges. A good illustration of its hardness is found in its employment in sawing stone and in drilling wells. The circular saw set with black diamonds readily eats its way through stone. In the rotary method of well-drilling, black diamonds are mounted around the lower edge of a tube-like tool. The tool is revolved, under lubrication with water, and produces a core which is extremely useful in showing the character of the rock formation through which the drill passes.

Among the charging abrasives there are many varieties—natural and artificial—all of them composed of sharp particles which embed themselves in the softer of two surfaces. One of the commonest of the natural abrasives is emery, which is of various grades as to hardness and other characteristics. Others are pulverized quartz, powdered glass, and the like. Among the non-charging abrasives there is a very wide range of selection, including rouge, Vienna lime, pikestone powder, tripoli and many others.

Lap for Plane-surfacing Lapping

For the plane-surface lapping of steel, the first requisite is an accurate surface lap. Theoretically this can be produced by taking three pieces of metal and grinding them until they fit interchangeably. In actual practice, however, more than three are needed to accomplish the desired results. If the lap is made by the well-known method of fitting three surfaces together interchangeably, by means of scraping and abrading, this involves, first, taking two cast-iron surfaces and rubbing them together with emery and oil between them. Both surfaces are abraded about equally, and under this process they come to fit rather accurately. A third surface is then introduced, and made to fit the others. By making these three pieces interchangeable we have produced, theoretically, three plane surfaces. As a practical proposition, however, this is impossible. The principal difficulty in effecting accurate lapping of a surface lies in the film of lubricant, abrasive, and even air, between the two opposing surfaces. This film prevents actual contact, and acts as a sort of cushion which permits one surface to rock on the other to a greater or less extent. The result is that the two surfaces do not exactly conform the one to the other. The operator may think that he is producing an absolute complement of any surface, by this method, but this cannot be done. The theoretical production of three plane surfaces which are interchangeable does not work out in practice.

In consequence of this factor, the operator is likely to find himself with one plane surface and one surface that is convex. Two convex plates, thus produced, can be used for lapping against each other. Theoretically they would abrade one another equally; but in practice they arrive at the same place already indicated, with one having a convex surface while the other is plane. Because of this condition it is always necessary, where accurately plane laps are required, to work with a number of them, selecting and using none but those having plane surfaces. To make any two of the planes have perfect contact is almost impossible, because of the air film that is always between them. This factor is more important than many realize.

The remedy for this condition lies in scoring the laps. For ordinary purposes score marks may be made 1/4 to 5/16 inch apart, in checker-board pattern. These marks may be shallow and narrow. They serve their purpose by allowing the oil film to be pushed aside, or sheared, from the surface of the lap, thereby allowing the two surfaces to come into closer contact. The air film is allowed to escape. In accurate measurement, it has been found necessary to score the surface of the anvil or base upon which the article to be measured rests, in order to allow actual contact of metal with metal without the interposition of the air film. In lapping, the same principle must be taken into consideration and steps employed to eliminate the obstacle to accurate lapping presented by the film of oil or air.

Dry Lapping

Dry lapping is much more accurate than so-called "wet lapping," in which a lubricant is used. The highest precision and the utmost accuracy are obtained by the scored lap, with dry lapping. In conducting this operation, it must be remembered that the danger of dry lapping is that the products of abrasion will glaze the surface of the lap. The glaze forms into a flake, and presently gets so thick that it rolls up into little masses which will scratch the work. In dry lapping, therefore, it is possible to lap for a short period only, after which the lap must be cleaned with benzol, kerosene, oil, or other liquid. The usual method is to take a very slight amount of lubricant or liquid on the palm of the hand and rub it over the surface of the lap—not enough liquid to float the work, but just enough to make the abraded particles of steel flow, or smear, to some extent, instead of flaking or balling. From time to time this "smear" is wiped off with the palm of the hand, which is kept moistened with a slight trace of oil. In this way, highly polished work can be produced. The lapping is not absolutely dry, but is best described as a compromise between wet and dry lapping. If this method is used, and the lap slightly scored to prevent the work from floating on the air film, quite accurate surfaces can be obtained.

Uniform Temperature Essential to Accuracy

In hand-lapping the greatest cause of inaccurate results is the difference in temperature between the lap and the work. With an accurate plane surface-lap, it is possible to produce surfaces that are either plane, convex, or concave, the form depending on the temperature of the lap with relation to the work. If the work is warmer than the lap, the result will be a convex surface on the work. If the work is colder than the lap, a concave surface will be produced on the work. If the temperatures are the same, the surface produced will be plane.

The temperature factor is always present. In the usual attempt to produce plane surfaces by hand-lapping, the operator holds the block in his hand. Because of the fact that the lap is colder than blood temperature, and that the block becomes warmed through contact with the hand, this method results in warm work and a cold lap. The lower surface of the block is therefore chilled by contact with the lap, and contraction of the surface is inevitable. The remainder of the block is warm because of the heat absorbed from the hand. When the warm block is placed on a cold lap, the block is immediately warped into a concave lower surface; and this, when moved across the surface of the lap, is abraded only on the edges or margins of the concave surface. The center cannot be touched, because of the hollow or concave formation, and the outer portions only are worn away. Under these conditions lapping might be continued until the lap and work fit each other perfectly, and one might suppose that a plane surface would be produced. We forget, however, that the block is warm throughout the greater portion of its mass, and that the lower surface is cooler, and therefore contracted. This condition becomes evident when the block is removed from the lap and the temperature equalizes itself throughout the mass, thus causing the lower surface to expand which results in a convex surface.

This is the principal reason why mechanics and toolmakers find it impossible to produce accurate plane surfaces from a surface lap, even when they know that the lap itself is an accurate plane. This factor of temperature usually produces convex surfaces, as does also the rocking effect of the oil or air film; both work the same way, which accounts for the inaccuracy so familiar to those who attempt to make plane surfaces from laps known to be accurately plane themselves.

Therefore there are two conditions necessary for the accurate duplication of surfaces. The first of these is that the temperatures shall be the same in both work and lap; the second is that there shall be no film of either oil or air between the two surfaces. When these conditions are fulfilled the result will be precision lapping, and this is easily achieved by bearing in mind the things that cause the trouble.

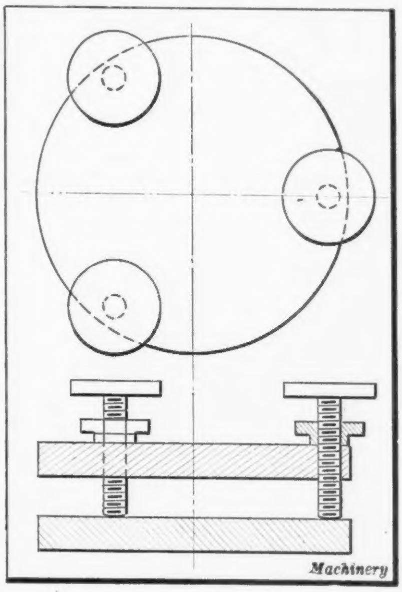
If the work could be done in a room in which the atmosphere is at blood temperature there would be no difficulty from temperature. Ordinarily, however, in cold weather, the temperature of the room is maintained at 68 or 70 degrees F. Under these conditions it is manifestly impossible to hold a piece of steel in the hand without raising the temperature of the metal. The lap, of course, is at shop temperature. We must bear in mind that the difference between shop temperature and blood temperature, on a cold day, is easily 30 degrees. We must also bear in mind that a block of steel 4 inches long expands approximately seven millionths of an inch for each inch of its length for each degree of rising temperature. Since the work is 30 degrees warmer than the lap, the contact with the lap results in shortening the lower surface of the block to the extent of 840 millionths of an inch (7 millionths × 4 inches × 30 degrees), which is an amount easily capable of bending the block into a surface highly concave if considered in terms of precision. Even the concavity is not accurate, for the simple reason that temperature conditions are constantly shifting.

How to Safeguard against Temperature Variations

The remedy for the temperature difficulties previously mentioned, lies in equalizing the temperatures, and keeping them uniform. For ordinary purposes, in shop practice, the quick remedy is to heat the lap to the temperature of the blood, or beyond. The same result is arrived at if the work is chilled to uniformity with the lap. Either of these methods, however, is only a makeshift, as it is impossible to keep the work cold or the lap warm. The permanent remedy, therefore, is to allow the work to remain in contact with the lap until the two acquire a uniform temperature, and then do the work without contact of the hands or of anything else that will warm up the work. It must be remembered that lapping itself is a heating operation, and that the work cannot be conducted too rapidly without rise in temperature. In the application of this remedy, the thing to do is to make a work-holder that will fit over the work without bending it. In the lapping of thickness gages, for instance, the work-holder should hold the work without exerting distorting pressure, and it must be so made that it may be moved about by means of a wooden handle, such as an old file handle.

The trouble arising from temperature distortion is much more marked with some laps than with others. In a diamond-charged lap, for instance, the particles of diamond are partially embedded and protrude above the general surface of the lap in a multitude of fine cutting points. These produce a surface which is not shiny, but gray. In this instance, the work actually rests upon the countless diamond points and does not come into contact with the metal of the lap itself. The result is that the transference of heat is greatly minimized, and there is no trouble from rocking upon an air film for the reason that the air can readily escape. With the emery-charged cast-iron lap the situation is quite different. In this case the surface is usually bright and polished, due to the fact that the emery is almost completely embedded in the cast iron. This permits metal-to-metal contact which is more or less perfect in character. This contact permits ready transference of heat, and at the same time permits the rocking effect of an air film. In view of this, it is obvious that, other things being equal, it is much easier to produce a precise surface with diamond dust than with emery or other abrasive creating a highly polished surface.

Another cause of inaccuracy in surfaces is that the fine scratches produced by lapping exert a peening or stretching effect on the surface. Take, for instance, a steel gage, 1 inch in diameter and 1/4 inch thick, highly polished on one side and more roughly polished on the other. This gage will usually be found to be convex on the dull-finished side and concave on the side that is highly polished. This condition is produced by the stretching or peening effect of the coarser scratches, which have a tendency to expand the side on which they occur, whereas the lack of such scratches on the other side causes an absence of this tendency. The result is that the gage will be warped in a way that is very perceptible when examined by means of an optical true plane. The obvious remedy is to take care to produce the same quality of finish on each of the two sides.



Device for lapping Plane Parallel Faces on Opposite Sides of a Block

Lapping Plane Parallel Surfaces Simultaneously

It is almost impossible by hand lapping methods to produce surfaces on both sides that will be plane and parallel, although when the two faces of a block are lapped simultaneously, almost all the aforementioned troubles automatically disappear. The rocking on the oil film, for instance, is approximately the same on both sides of the work, and consequently neutralizes the adverse effect. The air film obeys the same laws. The temperature effects are automatically equalized by reason of the intimate contact between the work and the upper and lower laps. Then again, since the lapping motion in this instance is usually produced mechanically, there is no contact of the hands. The polish is usually about the same on both sides, so that the peening effect equalizes itself on the opposite faces. The peening effect must be borne in mind, however, and care exercised to have the abrasive and other conditions the same on both upper and lower laps, in order that the polish will be identical and the peening effect avoided.

A simple and useful device for lapping plane parallel opposite faces on steel gages can be made by any mechanic with very little labor. (See the accompanying illustration.) Circular disks of 6 to 8 inches diameter are convenient for lapping gages and other small work having plane parallel opposite faces. These disks can be easily turned in any lathe. Each of them must be accurately planed on at least one face. When this has been done, three holes should be drilled and tapped in one of the plates, near the margin. Provide for these holes large-headed screws and lock-nuts, to act as support stops, or legs, for separating the lapping surfaces by any given amount to which the screws are adjusted. This lapping device may be used either in a horizontal or a vertical position. The vertical position is theoretically better for the reason that it is much easier to obtain the same polish on both sides when the laps are held vertically; the easier way, however, is to use them horizontally, by simply placing one lap on a work-bench, and the other on top of it, resting on the three screws. The work is placed between the two lapping surfaces and moved about by means of a bent wire or other device suitable for the purpose. The screws should be adjusted so that the two lapping surfaces are approximately parallel, and separated by the thickness of the work so that the latter will slide

freely between the lapping surfaces. This is accomplished by placing the work close to one of the screws and adjusting the screw until a certain tension is required to slide the work between the surfaces. The work is then placed close to the other screws, in turn, and the adjustment continued until the work slides with about the same resistance throughout the entire area of the lapping surfaces.

A fine grade of flour emery in kerosene is an excellent abrasive for this duplex lap. All that is necessary in preparing the material is to mix the emery with the kerosene in an oil can or similar container. From time to time, during the progress of the work, the lapping surfaces are wet with this solution of kerosene and emery. The work is moved back and forth between all parts of the lapping surfaces, in various directions, and the lapping continued until the final dimensions are approached. When this stage is reached, no attempt should be made to adjust the screws further, because it is impossible to adjust them to a point anywhere near the minute dimensions required for high precision. When the work slides freely and ceases to lap, the more minute adjustment is readily obtained by placing a weight upon the upper lap. No matter how accurately the laps may have been surfaced, it will usually be found that there is one tight spot where the gage will jam between the two surfaces, although sliding freely elsewhere. That is the point upon which to concentrate the movement of the work. A slight weight is usually sufficient to bend the lap to the extent necessary to furnish contact between the work and both laps, and thereby insure the needed abrasion.

By this duplex method, lapping can be done with a lubricant, and excellent finish and accuracy secured, with surfaces plane and parallel, and of any accuracy of dimension within the ability to measure. Where very high precision and finish are desired, the final operation should be to clean the laps, removing all lubricant, and finish by dry lapping. The dry lapping must not, however, be continued too long, or the laps will glaze, flake, ball, and scratch, as previously explained. When pure benzol is used to clean the laps, practically all traces of grease are removed, which leaves the laps dry, and this would result in scratches if the lapping should be continued too long. When commercial grades of gasoline are used to clean the laps, there will usually be enough grease to prevent trouble of this kind.

The practical difficulty in the operation of the duplex lap just described, is that any slight movement of the three legs supporting the upper lap changes the entire adjustment of the laps. It is therefore necessary to prevent the bottom of the screws from slipping and sliding on the surface of the lower lap, with loss of accurate adjustment. A convenient arrangement for this purpose is to use three clamps, which can be fastened lightly close to the screws, holding the two plates firmly and preventing slipping.

The method of procedure in obtaining the final accurate dimensions, is extremely simple. When it becomes necessary to take off a very slight amount, this can be accomplished by holding the work in the hand for a few moments, thereby heating it slightly and causing it to expand. The work is then quickly put between the two lapping surfaces and pushed through the tight spot a few times. When this is done, the metal will soon lose its heat, contract, and refuse to lap farther, because there is no contact. This process may be repeated, and by continuation of successive heatings and lappings, or by adding a weight, very accurate dimensions can be obtained.

It must not be assumed that the whole problem of accuracy is solved by the addition of the weight for bending the upper lap, nor through the heating of the gage by holding it in the hand. It must be remembered that it is absolutely impossible to make an adjustment that will result in removing the precise millionth of an inch that it may be desired to remove. What actually happens is that a very slight amount—perhaps a fraction of a millionth—is taken off at each stroke, or each pass between the lapping surfaces. The rate of lapping continues with regularity, and the time factor, or number of strokes, can be used for determining the desired amount of reduction. The rate of lapping should be carefully followed by counting the number of strokes. In this way, by measuring the results produced by any given number of strokes, it is easy to ascertain the rate at which the lapping progresses. This knowledge will serve as a guide to the number of strokes required to take off any given amount. In approaching the final dimension, great caution is necessary to avoid overshooting the mark.

It will be observed that in this process very accurately plane parallel opposite faces are produced by laps that are not of themselves accurate planes. By placing the weight upon the upper lap and bending it, the upper lap is made slightly convex, producing one place at least where the surfaces are closer together than at any other place. This bending of the lower face of the upper lap is exceedingly slight, and will produce a plane surface on the work, notwithstanding the fact that the lapping surface is convex.

In the process here described the lap is held horizontally. Thus there is a tendency for the larger particles of abrasive to settle on the lower lap, and there is further probability that the film of lubricant (the "muck" or "goo," as it is termed in the shop) is thinner on the upper lap than on the lower. This condition has a tendency to produce a difference in finish between the upper and lower surfaces of the work, and where extreme precision is desired, this is a factor to be considered. Where the laps are used in a vertical position the "muck" continually drains to the lower edges of the laps, and drops off, and this makes it much easier to obtain a uniform finish on both sides of the work. The vertical arrangement also prevents the settling of the larger particles of abrasive on the lower lap. On the other hand, lapping with the laps vertical is not so convenient or easy as in the case of the horizontal position.

It is practically impossible to lap surfaces to a sharp edge and still maintain perfectly true surfaces. The sharp edge will invariably produce what is known as "wire edge," and this may break off and get on the lapping surface, scratching the work. In many instances, the wire edge will be 80 to 100 millionths of an inch higher than the surface that it surrounds. To obviate this adverse factor, it is important that in preparing the blanks, all sharp edges should be carefully rounded or beveled off, to prevent the formation of the wire edge.

Temperature for Gage Standardization

Temperature is a vital factor in precise measurements. The man who seeks to make gages of high precision must always bear in mind that size means nothing when measured without relation to temperature. In this country the standard of measurement commonly employed for gage standardization is based on a temperature of 68 degrees F. As this temperature represents approximately average working temperatures, it has been adopted in preference to 62 degrees F. which was formerly used for gages because it is the temperature at which the standard yard bar is the correct length. (Incidentally it may be mentioned that the British standard is 62 degrees F. and the French standard 0 degrees C. or 32 degrees F.) For a gage an inch in length, every degree of rising temperature increases the length to the extent of about seven millionths of an inch, with a corresponding decrease for each degree below 68 degrees F. This must be reckoned with in the final results.

In this connection, it must be noted that while high-precision gages are made to be standard at 68 degrees, it is not necessary to use them at this temperature when measuring metal of the same coefficient of expansion. This is due to the fact that if both gage and metal have the same rate of expansion, it may be assumed that both have had equal expansion or contraction if both are at the same temperature. This does not hold good when the metals have different coefficients of expansion. In measuring other metals, such as copper, by means of a standard made of hardened steel, the two pieces must be maintained at the standard temperature of 68 degrees, or allowance made for the difference in their rates of expansion.

Gaging at the Point of Manufacture

First of Prize-winning Articles in MACHINERY's Contest on Interesting Gaging Devices and Methods

By FRANK H. MAYOH, Holyoke, Mass.

SYSTEMS calling for the inspection of work after its completion or after the removal of the work from a machine are in general use. The primary purpose of this article is to go a step further and emphasize the importance of gaging the work on the machine during its manufacture. The time to save the product from being spoiled is before the lathe tool or the punch has taken a cut at the wrong place.

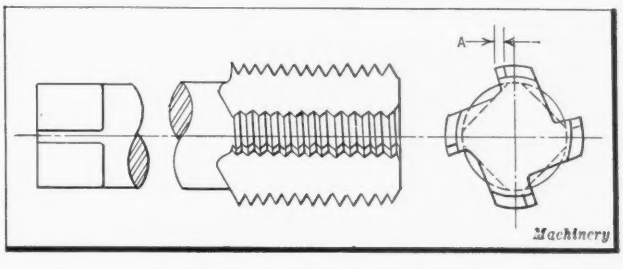


Fig. 1. Method of relieving Tap

It is surprising how often operators are criticized for producing inaccurate work where a simple expedient or a measuring device incorporated in a tool would make it difficult for the operator to machine the work incorrectly. For instance, in machining large taps it is customary first to thread the tap concentric and then back off the thread or relieve it, leaving a small concentric portion such as indicated at *A*, Fig. 1. In doing this, it is necessary to put the tap in a lathe having a relieving attachment, and pick up the thread so that the tool used in relieving will track in the thread previously cut by the threading tool. Anyone who has attempted to do this knows how difficult it is to pick up the thread.

To facilitate the relieving operation, the tap is heated so that the threads become thoroughly discolored or blued. The workman can then see whether the relieving tool is tracking properly and just how far the relieving operation has progressed. Thus he can judge quite accurately when the relieving cut is within about 1/16 inch of the cutting edge of the tap. The bluing practice may be employed to advantage when relieving cutters, remilling grooves and performing other operations where the eye can be depended on to do the gaging with the required accuracy.

Punch Equipped with Gages

A punch and die equipped with a scale and end stops is shown in Fig. 2. This die is used to pierce holes at different center distances in a bar, a section of which is shown by heavy dot-and-dash lines at *A*, while the die is shown at *B*. Detailed construction of the die is omitted in this illustration, as it is obvious that the work *A* simply passes over the die and under a stripper plate, and is held back against surface *D* by the operator, while the punch descends and pierces the hole at *C*, following which the work is moved along and hole *E* is pierced.

In order to accurately gage the position of the holes from the end of the work, a stop-pin *F* is incorporated in the die construction and the end of the work is held against this stop-pin while hole *C* is pierced. Pin *F* is mounted in a swinging bar *G*, which pivots on pin *H* in an adjustable carrying block *J*. The purpose of swinging bar *G* is to permit stop *F* to be swung back away from the work after hole *C* is pierced, following which the work is pushed against a similar stop *K* to locate the second hole *E*. Stop-pin *K* is mounted in a swinging bar *L* hinged at *M* in a carrying block *N*. Both blocks *J* and *N* are adjustably mounted on a steel bar *P*, which has a scale *R* attached to its upper face. On block *J* is an indicator *S*, the beveled end *T* of which is in line with the end of stop-pin *F*, while on block *N* is an indicator *U*, the beveled end *V* of which is in line with the end of pin *K*. Screws *W* are provided for clamping the blocks on bar *P* in the required positions for properly spacing the holes to be punched in the work.

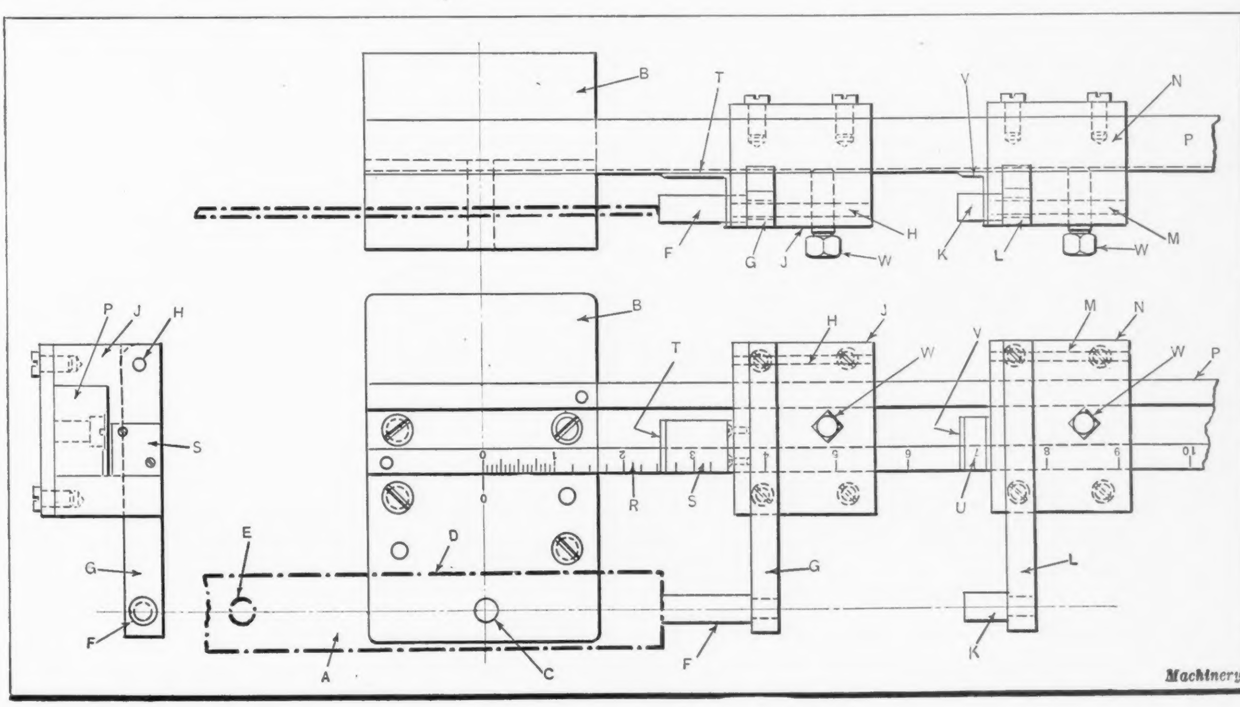


Fig. 2. Punch and Die equipped with a Scale and End Stops

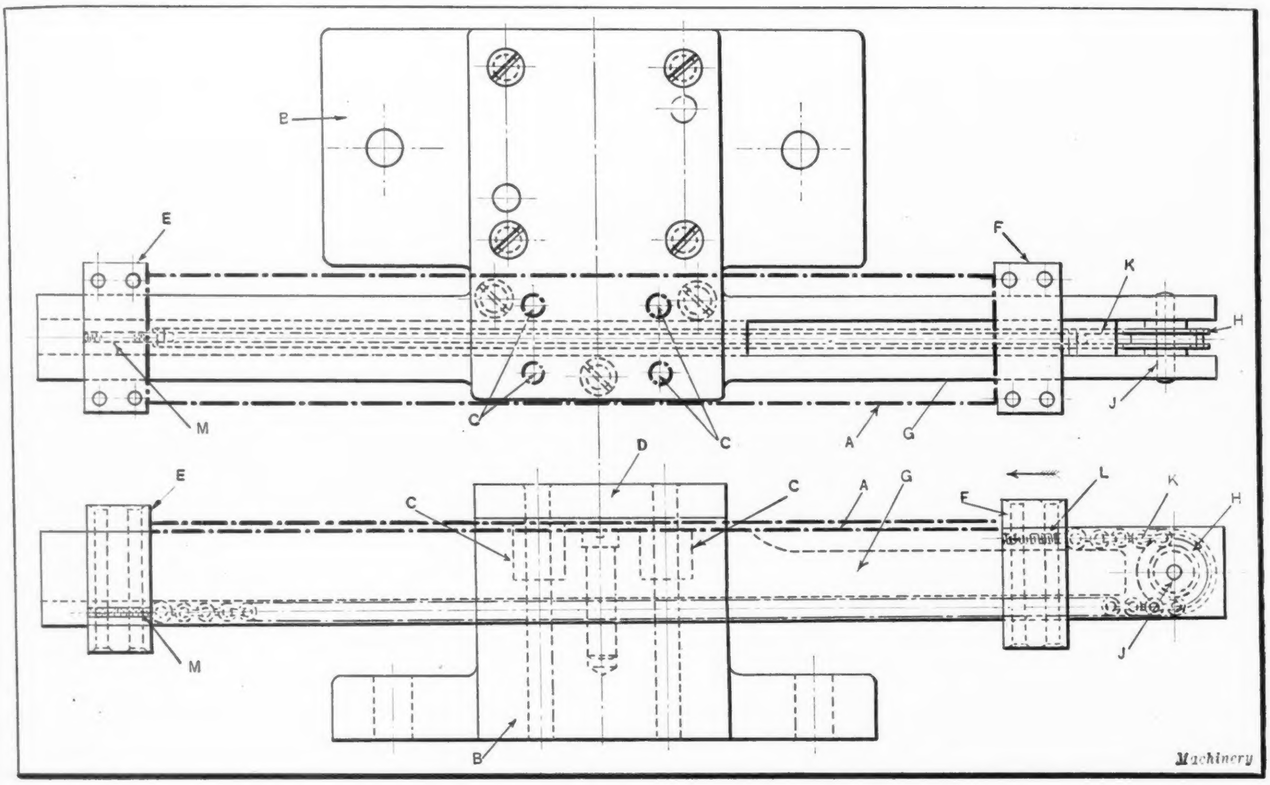


Fig. 3. Device that automatically centers Works in a Die

In using these combined gages and work stops, the operator tightens screw W when the indicating line T is at such a position on the scale that the first hole C will be located the correct distance from the end of the work. The indicator V is then set at the correct position from the end of the work. The work is next slipped into place, the first hole C punched, stop F swung out of the way, the work pushed against stop K, and hole E punched. The stop K is then lifted out of the way and the work pushed along against a fixed stop and another hole pierced, or the work can be removed as required. This type of stop is found most useful for punch press work and drilling operations.

Centering Fixture for Die

In Fig. 3 is shown a type of gage that automatically centers a bar in a die for piercing a group of holes. A gage of the same type can be used in drilling, milling, or other operatons where a quick centralizing device for the work is required. In the illustration, A indicates the work, B the die-shoe, and C the bushings used as dies for piercing the four holes shown in the plan view. The stripper plate is shown at D. The punch-holder (not shown), carrying four punches of any approved construction and working in conjunction with this die, performs the piercing operation.

As the parts A are made in various lengths, two sliding blocks E and F mounted on a carrying bar G are provided for centralizing the work. Blocks E and F are made in two pieces, pinned together, and in addition a sprocket or flanged wheel H is mounted so that it is free to revolve on a stud J. Over sprocket H passes a chain K which is attached to block F by means of a screw L and to block E by a screw M. This chain passes along the under side of bar G and over sprocket H.

When block F is pushed to the left, in the direction of the arrow, the chain causes block E to be drawn to the right toward the center of the die; consequently by putting a piece of work in place at A and then pulling block F over until it comes in contact with the end of the work, the work will be centered over the die, as sliding blocks E and F will both locate against the end of the work, thus jamming it between them. In removing the work, the operator simply pushes block E to the left, which causes block F to slide to the right. Various lengths of work up to the capacity of bar G can be accommodated by this arrangement.

It is interesting to note from a study of the three preceding examples that three different principles of construction are used in gaging and that three different human faculties are employed. In the first case, the operation of relieving the tap depends on the eye for gaging. In the second example, the operator depends on holding the work by hand against the stops for the degree of accuracy obtained; while in the last of the three examples the centralization of the work is automatically taken care of.

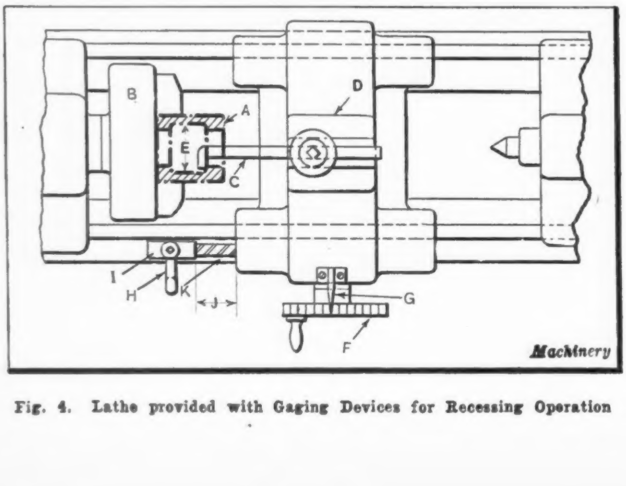


Fig. 4. Lathe provided with Gaging Devices for Recessing Operation

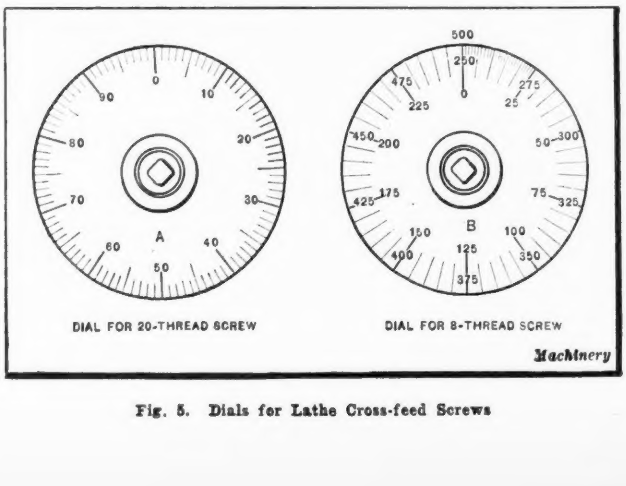


Fig. 5. Dials for Lathe Cross-feed Screws

Recessing Gage

The examples of gaging at the point of manufacture shown in Fig. 4 are involved in the operation of recessing a hole in a sleeve. The work at *A* is held in a chuck *B* mounted on the lathe spindle. Recessing tool *C* is held in the toolpost *D* on the cross-slide of the lathe. The hole in the work is first bored and reamed to size, and is then recessed at *E*. The recessing operation is performed by feeding the tool *C* into the hole the required depth for the recess, and then traversing the tool longitudinally to cut the recess to the desired length.

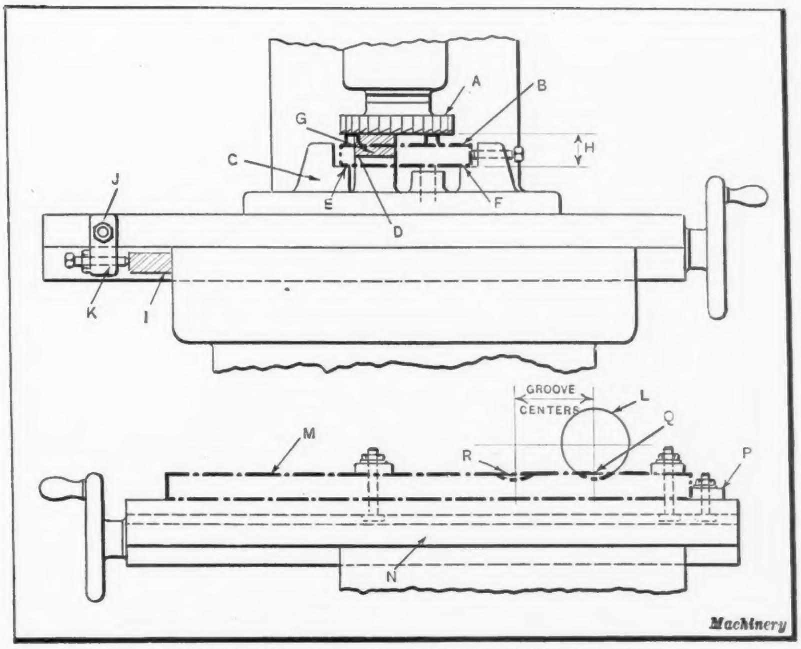


Fig. 6. Method of using Gage-blocks for Milling Operations

To facilitate accurate gaging or measuring of the recess, the lathe is provided with a dial *F* mounted on the cross-feed screw, and an indicator *G*, so that an operator may set the tool in the hole to the position where the recess commences and back-feed the tool until it just touches the metal. The tool is then fed back until it has reached the required depth, as determined by the graduations on dial *F* which read to 0.001 inch. A clamp *H* is also provided, which holds a block *I* on the ways of the lathe at a distance from the carriage equal to dimension *J*, a gaging block *K* being interposed between the block *I* and the carriage end. Thus with block *K* in position, the recessing tool is located at the beginning of the cut. The operator then removes block *K* to allow the tool to be fed until the end of the carriage comes in contact with block *I*, thereby gaging the position of the tool at the beginning of the recessing cut, and the length of the recess.

The provision of dial feeds and tool-locating stop-blocks facilitates performing many operations that must be done accurately and at a reasonable cost. Cross-feed dials should be made to indicate the diameter of the work turned in thousandths of an inch rather than the amount the tool is to be fed in, and this can be accomplished by having the dial graduated to conform to the lead of the cross-feed screw on the lathe, in the manner shown in Fig. 5. At *A* is shown a dial having suitable gradutions for a 20-pitch lead-screw, while at *B* is shown a dial that is suitable for an 8-pitch lead-screw. The first dial has one hundred graduations cut in it. As the cross-slide of the lathe would be advanced fifty thousandths inch at each revolution of the feed-screw, one revolution reduces the diameter of the work an amount equal to twice fifty thousandths, or one hundred thousandths inch.

The dials are preferably made adjustable on a sleeve in some approved manner, such as is common in milling machine construction. First a cut may be taken in the work, which can then be measured by a micrometer, following which the dial is set with the indicator point to the number of thousandths of an inch indicated by this measurement. The cross-slide can then be fed in by reading direct from the dial the amount necessary to produce work of the required diameter without the necessity of taking successive trial cuts and measurements until the work is the correct size.

As shown at *B*, the dial for an 8-pitch screw has two series of graduation numbers, the inner circle reading from 0 to 250, and the outer circle from 250 to 500 thousandths of an inch. This is desirable, as an 8-pitch screw will advance the cross-slide cutting tool a distance of 0.125 inch, which is equivalent to turning down the diameter of the work twice this amount, or 0.250 inch. The second row of figures, reading from 250 to 500, are placed on the dial so that it will read by half inches, as it is more convenient to work by half inches.

Referring to dial *B*, let it be assumed that a trial cut is to be taken in a piece having a diameter of 4.738 inches. Four and one-half inches would be mentally subtracted from 4.738 which would leave 0.238 inch. The dial would now be set to read 0.238 inch, and if the piece is to be turned down to a diameter of 4.625 inches, the feed-screw would be turned until the dial indicates 0.125 inch. Dials of this type are very convenient, as they take the guess-work out of turning in the lathe. The lines and numerals are usually put on the periphery of the dial, rather than on the face as shown in the illustration, Fig. 5.

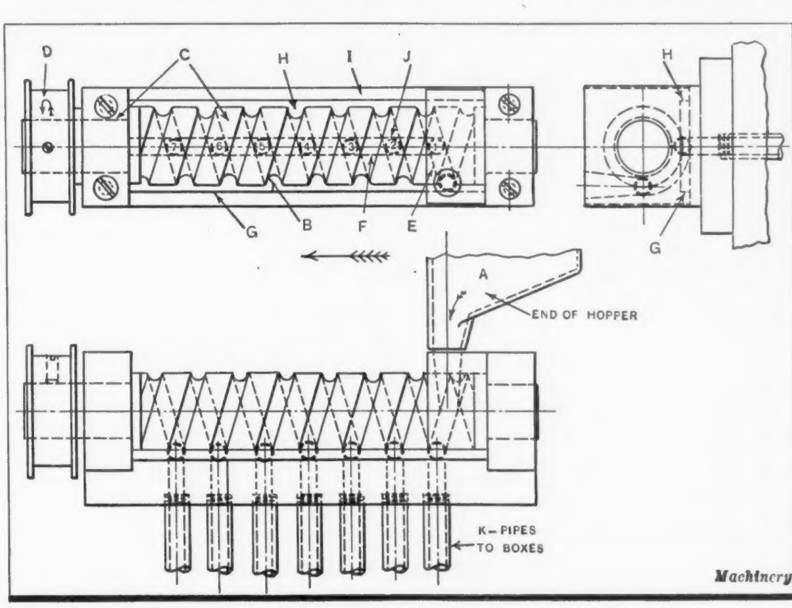


Fig. 7. Automatic Ball-measuring Device

In the upper view, Fig. 6, is shown a surface milling machine arrangement, where a cutter *A* is engaged in milling spots on the work *B*, which is held in a fixture *C*. The fixture has a surface *D* machined in accurate relationship to surface *E* and *F* upon which the work rests, so that a block *G*, which is accurate as to thickness, can be placed on surface *D*, and a cutter *A* brought into gaging contact with the top of block *G*, to insure maintaining

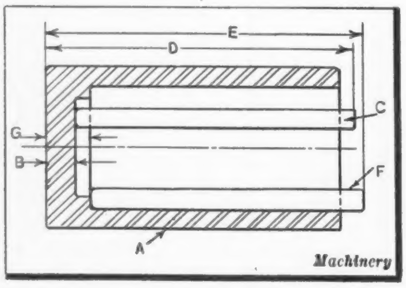


Fig. 8. Measuring Rods and Micrometer used for determining Wall Thickness

accuracy with respect to the thickness *H*.

In addition to this feature, another block *I*, is shown. This block is held in place by hand between the saddle of the milling machine and a screw *K*, in stop *J*, which is clamped to the table of the milling machine in the usual manner. This latter feature is shown, as it brings out an application of gaging blocks used in conjunction with a set-up for milling two radius slots in a bar held on a horizontal milling machine, as shown in the lower view, Fig. 6; here a cutter *L*, in the spindle of the machine mills a bar *M*, which is clamped to the table *N*, of the machine with its end located against a stop at *P*.

The bar *M*, has two radius slots, *Q* and *R*, milled in it; the measuring gage *I* (see upper view) between the stop-screw *K*, and the saddle of the machine being used to locate the table longitudinally for milling the first radius slot *Q*. The table of the machine is then dropped down, and with gaging block *I* removed, the table is fed longitudinally until stop-screw *K* comes against the saddle of the milling machine, in which position the table of the milling machine is raised until the cutter *L* mills the second radius slot *R*. This illustration, together with the previous one showing blocks clamped to the ways of a lathe, bring out clearly the importance of simple methods of gaging in maintaining accuracy at the point of manufacture and preventing spoiled work.

Use of Measuring Rods

An example of the use of measuring rods in conjunction with a micrometer for determining the thickness of a wall and the length of a shoulder is shown in Fig. 8. This method is employed for checking work after its removal from the machine. The work is indicated at *A*. In order to determine the thickness of the wall at *B*, a rod *C* is employed, and a measurement is taken over *D* with a micrometer; then by subtracting the length of rod *C* from this measurement, the thickness *B*, is determined. Likewise, by taking a measurement *E* with a micrometer over rod *F*, and subtracting the known length of rod *F* from the measured length *E*, length *G* is determined.

Rapid Ball-measuring Device

In Fig. 7 is shown a principle of gaging employed in measuring and sorting balls in large quantities. The balls are put in a hopper *A*, and are allowed to roll individually into a suitable spiral channel *B*, cut in a unit *C*, which is revolved by a belt-driven pulley *D*. The balls, in rolling out of the hopper, travel along a channel *E* and into a longitudinal channel *F*, made by placing two hardened plates *G* and *H* on a base *I*. Through base *I* is a series of holes, seven being shown in the illustration, although any desired number could be provided, depending upon the degree of selectivity desired in measuring the balls, as will be apparent from the following description.

The holes indicated at *J* increase in size gradually, hole number 1 being the smallest, and the others increasing progressively by thousandths (or other required size) until 7 is reached, which is the largest hole. From these holes is a series of pipes *K*, leading into seven different boxes beneath the bench on which the entire gaging apparatus is mounted. As the shaft unit *C* revolves, the balls are traversed longitudinally in the direction of the arrow between plates *H* and *G*, being held up by them as the channel formed by the plates is slightly tapered until they pass by a point where the width of channel *F* permits the balls to fall through into some one of the holes.

All the small balls will pass through hole 1 and through the pipe leading therefrom into a box. The next sized balls will pass through hole 2; likewise, the next larger balls will pass through hole 3, and thus progressively in the same manner until hole 7 is reached where all balls too large for the other holes will drop into the box below.

This gaging apparatus briefly described is a form of measuring device that is practically automatic in action. Where the nature of the work permits of its use and there is sufficient volume of work to justify the making of such an arrangement, quantity gaging is assured, and what actually takes place is that the balls are carried along by a revolving spiral groove over a gradually widening groove until they fall through at some spot over one of the holes, and are thus sorted.

Disk-measuring Device

A type of measuring device that may be mounted on the bench for measuring work similar to coins is shown in Fig. 9, where the work is indicated by heavy dot-and-dash lines, and the measuring device consists of a block *A*, having a slot *B* in it. In this slot is pinned a hardened steel piece *C*, that forms one measuring surface for the work. Mounted in another co-acting block *D*, is an adjustable screw *E*, which is hardened and ground and has a check-screw *F*, behind it. In addition, a hardened and ground pin *G* slides in this block, which is backed up by a spring *H* and screw *I*. There is a shoulder *J* on pin *G*, which prevents the beveled end of this pin from protruding more than the desired amount *K*, beyond block *D*.

Blocks *D* and *A* are held together by dowels *L* and screws *M*, the distance *N* being equal to the minimum diameter of disk *P*, that will pass the inspection test. The distance *R* is equal to the maximum diameter of a disk that will pass the inspection. An inspector, in using this gage, simply takes a handful of disks and pushes them one after the other through the slot *B*. The disks will snap by the spring pin *G*, with a slight tension if they are within the required limit, but if there is no tension, the minimum diameter *N* is too small, and the disks are rejected. If the disks are not too small and they will pass by screw *E*, set to the maximum diameter *R*, they will drop through a hole in the bench on which the measuring device is mounted. If they do not pass by *R*, they are pulled back and laid to one side, as they are too large to pass inspection. It will be seen that this device is very rapid in operation.

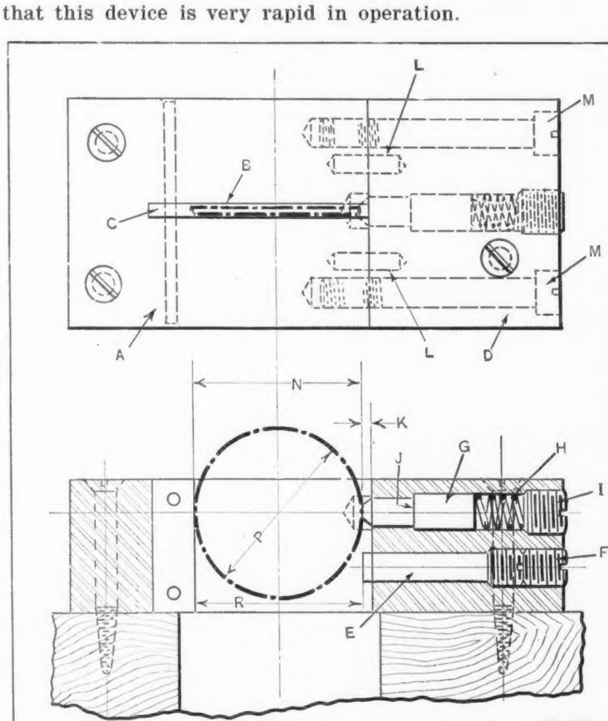


Fig. 9. Device for gaging Disks

If the work is of the correct size, the inspector merely snaps the disk by the spring pin and it falls past the maximum gaging size *R*. This device would probably not be accurate enough for use in measuring where a plus or minus tolerance of less than 0.005 inch must be maintained, although it is accurate enough for greater tolerances.

Gage for Testing Swaged Part

An unusual type of gage developed for the purpose of measuring the thickness and the angle of a piece relative to a bar on which it is swaged is shown in Fig. 11. In this illustration *A* indicates the work and *B* the angle of the swaged portion which is reduced to a thickness equal to *C*. The body of the gage *D* has a slot in it to receive the work *A*, and with the work held against the lower surface of this slot, the user sights along the angle of a pin *E*, where it rests against the swaged portion of the work *C*. Pin *E* is beveled so that the sighting edge is narrow, as is customary in form measuring gages. It is prevented from turning by a small dowel *F*, which comes against a flat on the pin.

The flat spring *G*, which has a tendency to keep the pin *E* in contact with the work is held in place by a screw *H*. The upper end of screw *H* is slotted to permit it to straddle the flatted sides on the measuring pin *E*. In contact with the upper end of pin *E* is a lever *J* which pivots on a stud *K*. Lever *J*, in combination with a series of indicating lines on the body of the gage *D*, at the pointed end of indicator *J*, measures the thickness within plus or minus 0.003, there being three lines either side of the zero point which represent 0.001 inch each. In using this gage, the work is merely slipped into place, and the inspection is made by sighting along the upper line at *C* to see if the angle of the work corresponds with the pin angle, and at the same time if the pointer indicates that the thickness is correct within the specified limits.

Testing Position of Holes in Stamping

A gage for measuring the location of two holes relative to a formed eye on a stamping is shown in Fig. 10. In this gage, the work *A* is slipped over a fixed pin *B*, held in the body of the gage *C*. There is a slot at *D* that allows the work to be located radially around *B* as a center. The knurled handle shown in the illustration is provided for convenience in holding the gage.

Two knurled gaging plugs *E* and *F* are slipped into holes in the work to determine if the holes are in the proper position with relation to the eye *B*. The measuring plugs *E* and *F* have "Go" and "Not Go" sizes on them, as shown in detail by the view in the upper right-hand corner of the illustration. The small diameters must go through the holes in the stamping, while the large diameters must not go through the holes. This gage is rather slow in use, and when employed for gaging stampings, it is applied only as an occasional check to make sure the work is correct as it comes from the dies. This general principle of gaging is one that is adaptable to a great variety of conditions.

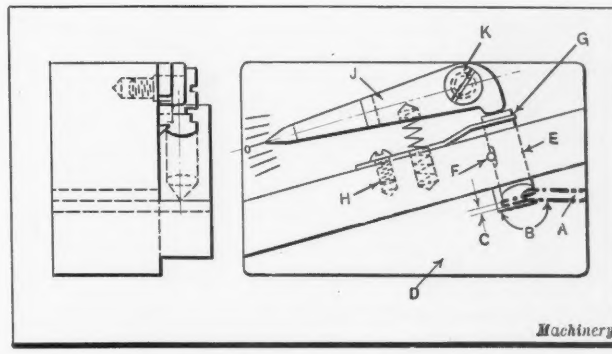


Fig. 11. Gage for testing Angle and Thickness of Forged Part

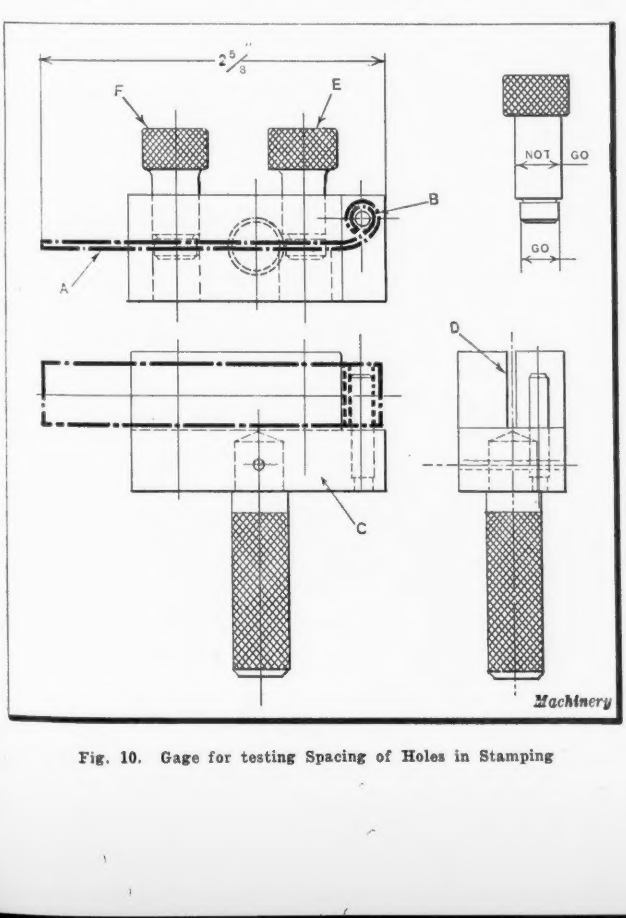


Fig. 10. Gage for testing Spacing of Holes in Stamping

* * *

PRODUCTION COSTS HERE AND ABROAD

An important subject is brought up by A. R. Marsh in an article in the *Economic World*, in which he points out that many misleading conclusions are drawn in regard to the cost of production in different countries by basing the estimate of the cost upon the average wages paid. "No process," says Mr. Marsh, "is more apt to give rise to misleading conclusions about the relative cost of production and the relative ability of various industries to compete in the world's markets, than that of comparing the bald figures of the wage rates or other rates of compensation obtaining in different countries. The truth is that the question of the ultimate cost of production in a given country is an extremely complex one, many other factors entering into the determination of this cost besides the amount of remuneration of the productive workers."

Statistics compiled in England before the war, in which comparison was made between the mechanical equipment used by workers in various British industries as compared with similar industries in the United States, showed that in the American industries from two to five times as much machinery was in use for a given number of workers as in the same industries in Great Britain. The statistics also showed that the per capita production of the American workers is larger than that of the British workers in practically the same proportion as the employment of mechanical equipment. The assumption is warranted that if the fundamental conditions of industrial production in Germany France, Belgium and Italy were investigated in the same manner, it would be found that the industrial wage rates of these countries bear about the same relation to the productivity of the individual worker as wages and production in the United States bear to each other.

* * *

The shipment of loaded motor trucks by rail between large industrial centers has recently been suggested in England as a new method of coordinating railway and highway transportation. The suggestion does not come from a mere layman, but from the Midland & Scottish Railway, one of the large British railway systems. The primary object of the plan is to expedite traffic between points not within easy trucking distance, by eliminating the transfer of goods from railroad cars to motor trucks at terminals. The railroad mentioned believes that the plan offers such substantial advantages to the railroads, trucking companies, and the general public that its adoption should receive serious consideration.

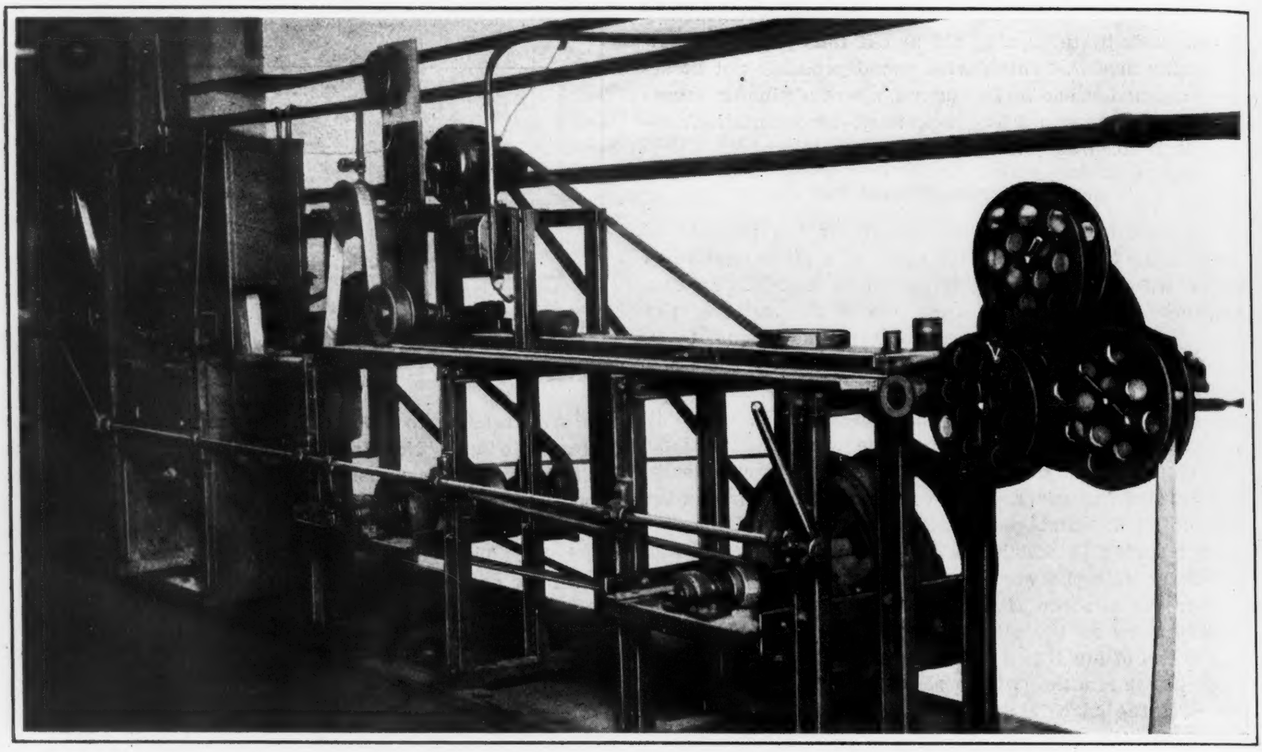


Fig. 1. Automatic Machine in which Brass, Copper, or Steel Strip Stock is tinned on Both Sides

Tubing Made from Strip Stock

How Flat Stock is Rolled and Sweated into Double-wall Tubing

By CHARLES O. HERB

COPPER, brass, and steel tubing in sizes that have many applications, such as in automobiles for feeding gasoline from the supply tank to the carbureter and for carrying away the overflow of radiators, is manufactured in large quantities by a new process developed and patented by Harry W. Bundy, president of the Bundy Tubing Co., 4845 Bellevue Ave., Detroit, Mich. The tubing is produced from strip stock that is approximately twice as wide as the circumference of the tubing, and one-half as thick as the tubing wall. Briefly, this stock is first completely tinned in an automatic machine, and then rolled into a tube, soldered, accurately sized, and cooled in a single operation performed in another automatic machine.

The stock is rolled twice about a complete circle so as to result in a double-wall thickness. The sweating produces a solid wall that appears as though the stock were of double the actual thickness and rolled but once. In this rolling operation, the tubing is produced at the rate of from 85 to 120 feet per minute. It is manufactured in various sizes, from 1/4 to 1/2 inch outside diameter and from No. 32 to No. 18 gage. In addition to the applications mentioned, the tubing is used in place of push-rods for operating the valves of automobile engines; for feeding lubricant in various machine tools, such as screw machines; for feeding fuel to oil stoves; and in certain novelties such as air-guns. The manufacturing methods will be explained in detail in the present article.

The strip stock is bought in coils containing from 300 to 600 feet of stock, depending upon the thickness of the material. These coils are brought to the tinning machine shown in Fig. 1, with two holes blanked through the starting end and two projections bent upward at the other end. The coils are mounted on two of the spools seen at the right-hand end of the machine. In starting a new coil, the projections on the end of the preceding strip are hooked into the slots of the new strip and bent over. Hence, the new strip is simply carried through by the old. The stock is tinned at a speed of about 400 feet per minute, and thus one tinning machine turns out sufficient work to keep several tube-rolling machines busy.

Tinning the Strip Stock

As the stock leaves the spool on which the coil is mounted, it passes under the third large spool, over a small roller, and then over a flat table about 8 feet long, to the idler pulley *A*, Fig. 2. In traveling over the table, any kinks that may have been caused by the stock having been wound into a coil are straightened out. From pulley *A* the stock passes up over pulley *B* and then down beneath two pulleys in tank *C*. This tank contains acid which removes all grease and dirt in preparation for tinning. From the acid tank, the stock passes between two rubber-covered rolls which wipe off the acid, and then over pulley *D* and down beneath a pulley in a tank located behind cover *E*. This tank contains the tinning bath, which is kept constantly at a temperature of from 500 to 550 degrees F.

The bath is a definite mixture of tin and lead, and is carefully checked four or five times a day. The entire bath is renewed every three or four days to eliminate any foreign matter that might result in imperfect tinning. A flux is maintained on the surface of the bath to keep it clean and easy-flowing. The tank is heated by means of two 1-inch gas pipes beneath, with holes in them. When the machine is in operation, the cover is lowered to conserve the heat of the bath and carry off fumes.

The stock is drawn from the tinning bath by two small rollers at *F* which also serve to clean excess tin from the strip. As the stock leaves the enclosure above the tank, it passes between two scrapers at *G* which remove any surplus tin still adhering. This surplus falls into a gas-heated trough *H* from which the melted tin drains back

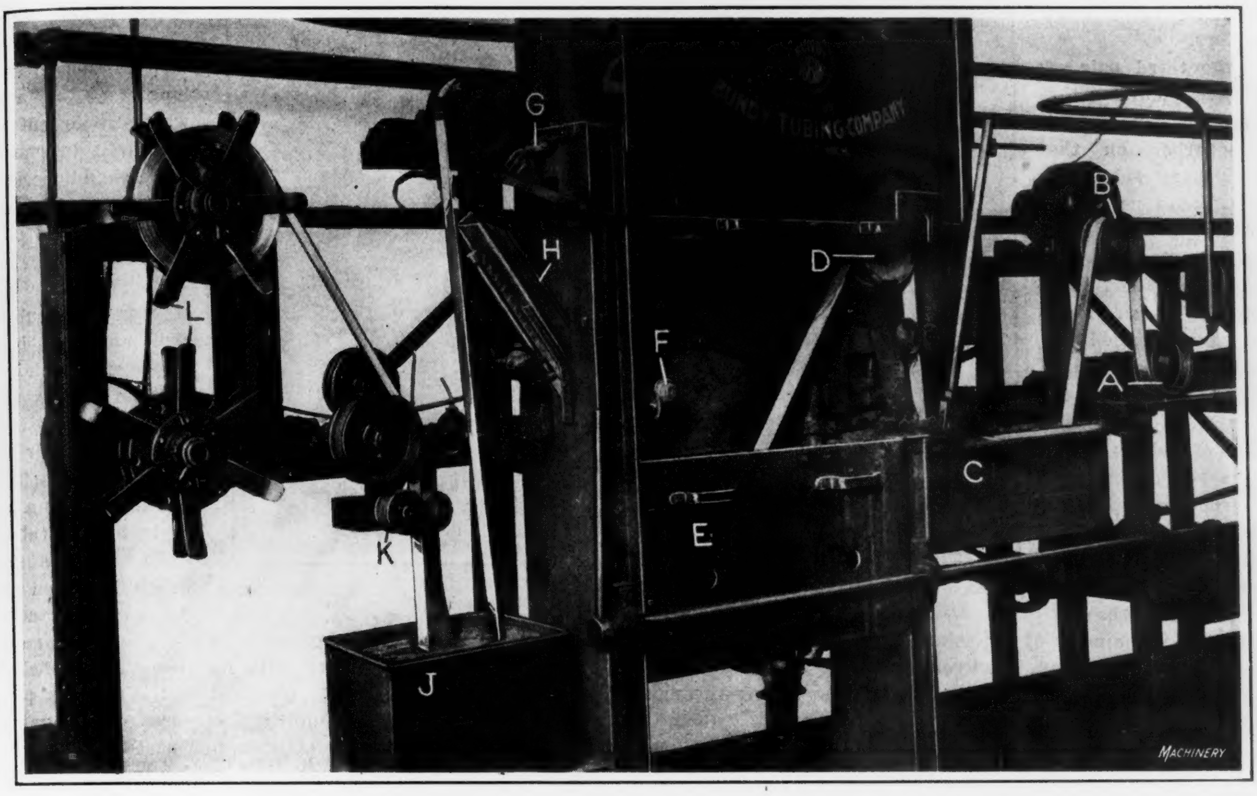


Fig. 2. Left-hand End of the Tinning Machine shown in Fig. 1

into the tank. Two small gas jets heat the stock just before it reaches the scrapers, and keep the tinned surface in a softened state for the passage between the scrapers.

From the pulley above the scrapers, the stock passes down under a pulley in tank *J*. This tank contains a hot water bath that cools and thoroughly cleans the tinned stock, which is then dried as it passes between the rubber-covered rolls *K*. Naturally, water remaining on the stock is evaporated because of the heat. From these drying rolls the stock is drawn over another idler pulley and then on one of the coil winding devices *L*. These winders are driven from a one-horse-power motor, and together with pulleys *F*, furnish the power for pulling the stock through the entire machine. The drive from the motor is through a countershaft at the right-hand end of the machine, as shown in Fig. 1, and then through intermediate pulleys to the coil winders. The construction of the winding devices is such that a coil can be quickly removed after the stock has been cut by a pair of shears. The new coil is started by simply giving a quick turn of the stock around the other spool. There are two speeds of operation for this machine, a fast speed for the tinning, and a slow speed that is used when attaching the end of a new coil to the end of the preceding coil. This obviates stopping the machine entirely in starting a new coil, and prevents the material from being kept stationary at any time in the tinning bath.

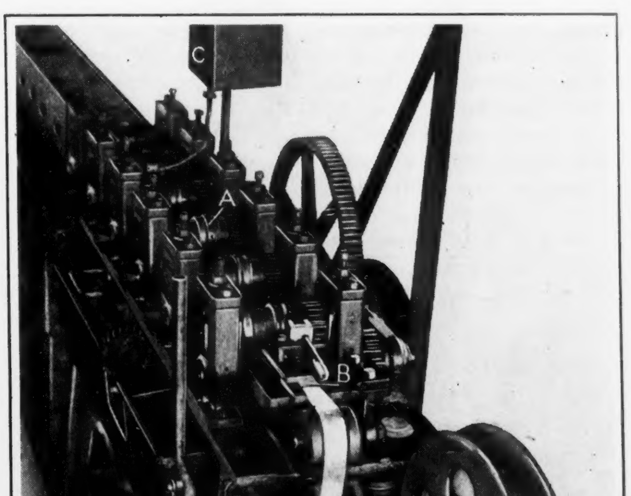


Fig. 3. Series of Rollers which curl the Tinned Stock into Double-wall Tubing

Rolling the Stock into Tubes

The production of the tubing from the tinned stock is accomplished in the machine shown in Figs. 3, 4, and 6. From several spools, one of which may be seen in the foreground in Fig. 3, the stock is fed down into a tank which contains acid that cleans it of any grease or dirt that may have accumulated since it left the tinning machine. From the tank the stock passes up between rubber-covered rollers which wipe off the acid, and then into the machine proper. Here it first encounters six pairs of rollers that roll the tubing to approximately the required size. These rollers are mounted as shown at *A*.

Just before entering the first pair of rollers, the stock passes between two flat surfaces at *B* which produce a slight tension on it and prevent it from buckling as it enters the rollers. The first pair of rollers turns up each edge of the stock slightly and raises it to a generous radius at the middle.

Between this and the next pair of rollers, and between all successive rollers, the stock passes over a surface that is shaped to correspond with the under side of the stock. The second pair of rollers curls each side somewhat more, but from here on all curling in done on the right-hand or rear edge only. As it leaves the second pair of rollers, the stock is guided by a long slender arbor which extends through it until after it leaves the final pair of rollers. This arbor is smaller in diameter than the inside of the finished tube except at the next to the last

and the last pair of rollers.

The third pair of rollers curls the stock partly around the arbor on the right-hand side, and the fourth pair continues this process. As the stock passes from the fourth to the fifth pair, acid is again applied by means of a brush fed from tank *C*. The fifth and sixth pair of rollers complete the curling of the double wall, as shown in Fig. 5. The arbor diameter at these rollers is the same size as the desired inside diameter of the tube, a limit of 0.002 inch being held on this dimension. The rollers are all gear-driven and, together, furnish the power for feeding the tubing through the entire machine.

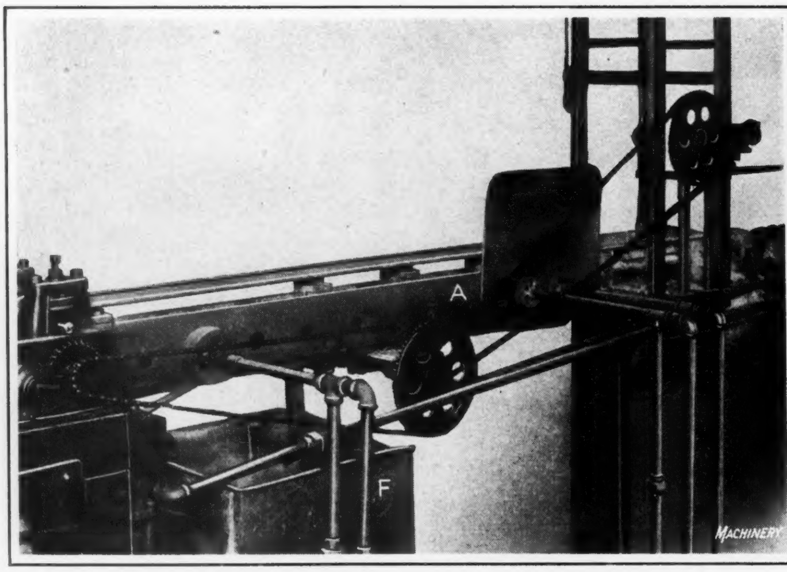


Fig. 4. Rear View of the Tube Rolling Machine

Sweating, Soldering, Sizing, and Cooling

When the tubing leaves the last pair of rollers, it enters a preheating pipe, about 4 feet long, which is contained in housing *A*, Fig. 4; this illustration shows a rear view of the machine. Gas flames play against the bottom of this pipe to heat the tubing. From the preheating pipe, the tubing enters a sweating die about 2 feet long in which the temperature is raised sufficiently to make the tin flow on all surfaces. This die is located beneath the cover *B* shown in Fig. 6. At *C* wire solder is fed to the tubing through an opening in the die, to cover the outer seam.

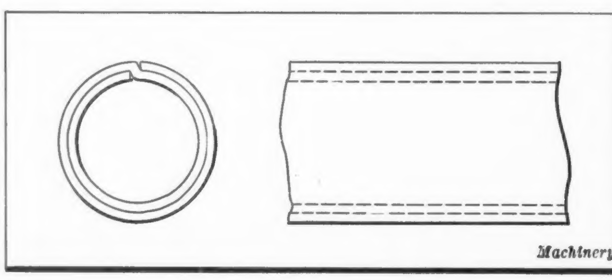


Fig. 5. Enlarged Drawing showing the Construction of the Tubing

After the tubing leaves the sweating die, it passes through a series of five dies *D* which bring the outside diameter to size, also within limits of 0.002 inch. These dies are simply made of cast iron and are easily replaced. They are heated by gas flames. Between the first and second dies molten solder is again applied to the tubing to insure a smooth, clean seam. The solder is drawn from both spools by means of rolls driven by sprockets and chains from the main drive of the machine, as illustrated in Fig. 4.

From the sizing dies the tubing enters pipe *E*, Fig. 6, in which hot water is circulated to lower the temperature of the tubing. This water is pumped from tank *F*, Fig. 4. The tubing may be seen leaving pipe *E*, at *G*, Fig. 6. It then enters a long small-diameter pipe *H*, which guides it on a long table, after which it is cut off to length by means of a hand-operated knife located at the left-hand end of pipe *H*.

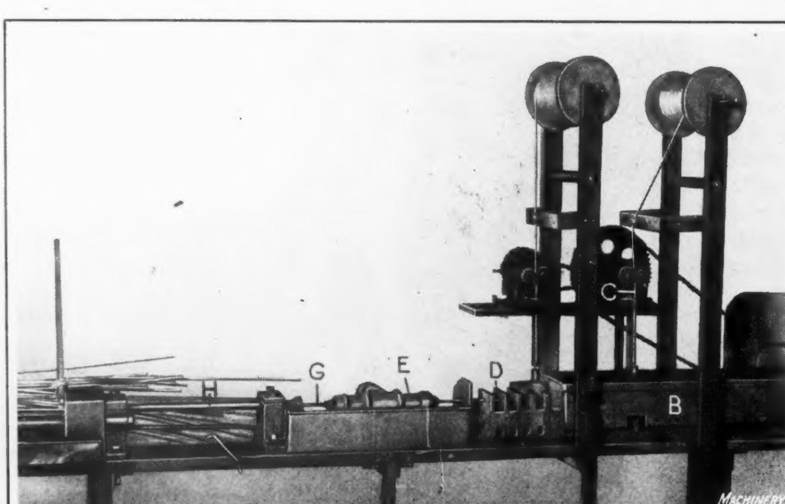


Fig. 6. Finishing End of the Tube Rolling Machine where the Tubing is sized, cooled, and cut off

An automatic cut-off for the tubing has recently been developed which consists of a carriage equipped with a 5-inch motor-driven circular saw. This carriage is drawn along by the tubing when the desired length has been fed, the saw advancing transversely to cut off the stock while the carriage is pulled longitudinally. When this has been accomplished, the carriage is automatically returned to the starting position where it remains idle until the necessary amount of stock for the next piece has been fed past it. This device makes it possible to cut the tubing neatly without crushing, and thus eliminates waste. Tubes are usually cut in lengths of 100 feet and then into shorter lengths and bent into various shapes to suit the needs of customers. A number of interesting devices have been developed for bending tubes in quantity into different shapes.

Testing for Leakage

Short-radius bends can be made with tubes manufactured by this process without fracturing the wall, and it is rarely that a defective tube is produced. However, in order to make sure that the product is satisfactory, each tube is tested for leakage. This is done by submerging the tube in water, as shown in Fig. 7, and blowing air into it; a pressure of 15 pounds per square inch is employed for this test, unless the tube is to be used in high-pressure installations, in which case a pressure of 100 pounds per square inch is used. It is stated that out of over 4,000,000 tubes supplied to one concern, the number of rejections has not been more than 500. The girls simply hold one end of the tube shut with a finger and insert the other end into an air valve which opens as the tube is pushed into place and closes automatically as it is withdrawn. Any leaks are indicated by air bubbles rising to the surface when the valve has been opened. Each girl can inspect more than 13,000 tubes per nine-hour day.

Fig. 7. Inspecting Tubes by forcing Air into them while submerged

Different Applications

A number of applications of this tubing were mentioned at the beginning of this article, but many more are brought to mind by the examples shown in Fig. 8. The small coil near the upper left-hand corner of this illustration, which has twelve winds, is about 2 inches outside diameter. Even coils of this diameter can be made without fracture. In a series of tests conducted by the National Board of Fire Underwriters, such a tube was made by winding around a pipe, then pulled apart and rewound. This was repeated twice, without leakage, when the specimen was subjected to a pressure of 25 pounds per square inch while submerged in water. Similar bends were made with the seam located in various positions, but this did not appear to have any effect on the tubes, either from the standpoint of leakage or ease of bending. Vibration, freezing, fire, and uniformity tests were also conducted by the Underwriters' Laboratories, all of which the tubing passed successfully. In the vibration test a piece of tubing filled with gasoline was vibrated in a machine for 5 hours. At no time did leakage of the tubing occur.

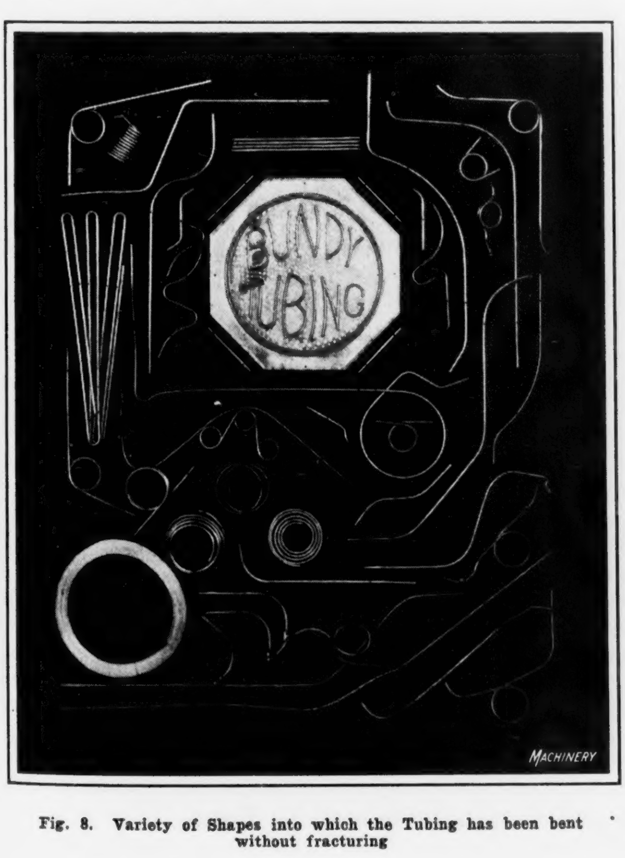


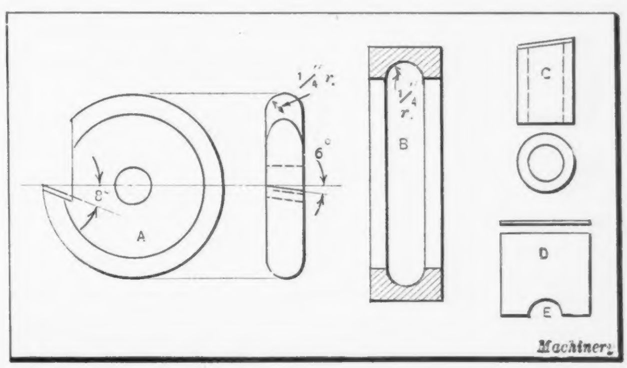
Fig. 8. Variety of Shapes into which the Tubing has been bent without fracturing

FORMING TOOL FOR CIRCULAR GROOVES

By CHARLES KUGLER

The writer was recently confronted with the problem of grinding forming tools like the one shown at *A*, for turning grooves in ball bearing races of the type shown at *B*. The radius of the groove was 1/4 inch, and the cutting tool was required to have clearance angles of 8 and 6 degrees, as shown in the illustration. Obviously, a tool ground to a radius of 1/4 inch and then cut away to obtain these clearance angles would not cut a perfectly formed groove. In order to grind the tool to the required shape, it was necessary that an accurate templet be provided. A piece of brass tubing *C* was bored out to a diameter of 1/2 inch to obtain the required outline for the templet. This piece of brass was then set in a toolmaker's vise mounted on a milling machine, after which the vise was swung to an angle of 8 degrees one way and 6 degrees the other. A cut was then taken across the end of the piece of tubing. The outline thus formed at the intersection of the inner and end surfaces of the tube corresponded to the outline required on the templet.

The next step was to place the brass tube on a piece of 1/32-inch sheet steel and scribe the required contour on the sheet metal. The templet was then made from the sheet metal by filing the material away up to the scribed line and cutting off the end. Next the tool was ground to the specified clearance angles, after which the templet *D* was used as a guide in grinding the tool to the required shape. In using the templet, a piece of flat glass was placed on the cutting surface of the tool and the templet laid flat against the under side of the glass with its formed portion *E* in contact with the surface being ground. This method of applying the templet to the work permitted very close duplication of the exact contour or gaging portion of the templet. The same method of producing forming tools and cutters has been used by the writer for work of various sizes with equally good results, and it can also be used to produce circular forming tools for external work.



(A) Tool for forming Groove in Part B; (C) Brass Tube used in scribing Outline on Templet D

* * *

EXTENT OF COLLEGE TRAINING

In an address at Harvard University, President Hopkins of Dartmouth College stated that there are now 600,000 men and women being educated in American colleges and universities. It is estimated that altogether between 800,000 and 900,000 men and women have been graduated from American colleges since the time the first institutions of this kind were established, so that at the present time the number of those attending college is 70 per cent of the total number that has been graduated in all the years up to this time. It is obvious from this that the college man is going to take a much greater part in the activities of the community than in the past. It is this that makes it all the more important that college courses are made to fit the needs of men in their everyday life work—to the end that colleges will graduate not merely *learned* youth, but *educated* men and women.

HEAT RADIATION

When a body is at a higher temperature than the surrounding bodies, it will radiate heat to those that are of a lower temperature. The heat rays proceed in straight lines, and the intensity of the heat radiated from any one source varies inversely as the square of the distance from the source. The rate at which heat is radiated by one body and absorbed by another depends upon the temperature difference and the character of the radiating and absorbing surfaces. Dark and rough surfaces radiate and absorb more heat than smooth and polished surfaces; hence the covering of steam pipes and boilers should be smooth and of light color. Polished pipes will lose less heat than those that are left rough. The quantity of heat radiated by a body is also a measure of the amount of heat that it will absorb if it is exposed to the rays of heat. A polished surface will absorb only part of the heat and reflect the remainder, while a black and rough surface will absorb nearly all the heat.

"HAND" OF LATHE AND PLANER TOOLS

The tools used on lathes and planers may be either right-hand or left-hand, depending upon the shape of the cutting end. According to common usage, lathe tools are designated as "right-hand" when the tool is adapted for cutting from right to left, the cutting edge being on the left-hand side as the tool is seen from above. Thus, a right-hand side tool, for example, is adapted for facing the right-hand side of a collar or the right-hand end of a shaft, and vice versa for left-hand side tools. The "hand" of a lathe tool, therefore, seems to be related to the location of the surfaces the tool is adapted for cutting, rather than to the position of the cutting edge, since a right-hand tool has its edge on the left-hand side, and the reverse is true for a left-hand side tool. Planer tools, however, are usually designated as right-hand when the cutting edge is on the right-hand side, assuming that the tool is being held horizontally and is seen from above, whereas left-hand planer tools have the cutting edge on the left-hand side. If a planer tool is in the working position, then, as viewed from the front of the planer, a right-hand tool has its cutting edge on the left-hand side and it feeds from right to left, the same as a right-hand lathe tool. The foregoing method of designating right- and left-hand planer tools has never been applied universally, but it seems to agree with the most prevalent usage at the present time. It would be preferable, however, in case these names were standardized, to have them agree as to the "hand" for both lathe and planer tools of the same general type or shape.

COLD TEST OF OIL

The effect of decrease in temperature upon lubricating oils is not the same as on fluids such as water, glycerin, etc., which have fixed freezing points. Lubricating oils, which contain elements having different melting points, often deposit some of these elements before the entire mixture solidifies; consequently, the "cold test" or setting point of an oil may represent the temperature at which the solid matter begins to separate, or it may be the temperature at which the oil loses its fluidity. The setting point of a Scotch mineral oil is the temperature at which the solid paraffin begins to separate. Some pale American oils of high viscosity, Russian oils, and all dark opaque oils, which either deposit no paraffin or in which the separation cannot be seen, are considered to have reached the setting point when they cease to flow.

DIELECTRIC

In electricity, the word "dielectric" indicates a non-conductor of electricity; a dielectric body, therefore, is an insulating body. The dielectric strength of a substance is the measure of its insulating qualities; the greater the dielectric strength, the better the material is as an insulating means. Dielectric strength is often indicated by stating the puncturing voltage for a thickness of 1 millimeter (0.0394 inch) of the material.

FILE DEFINITIONS

The length of a file means the distance from the point to the heel and does not include the tang. The heel is that end of the file body adjacent to the handle. A blunt file is one having the same sectional shape from the point to the tang. The coarse grades of single-cut files are sometimes called floats. Safe-edge means that the edge or side is smooth and without teeth, and may be presented to a surface that does not require filing. Over-cut is a term used to describe the first series of teeth on a double-cut file. Up-cut means the series of teeth superimposed on the over-cut series of a double-cut file. Re-cut means the working over of old worn-out files by annealing, grinding out the old teeth, re-cutting, hardening, etc. Re-cutting is seldom practiced at the present time. The term superfine (or super) cut is used by Lancashire file-makers to designate the grade of cut known in the United States as "dead-smooth." Taper is used to distinguish a file having tapering sides from one that is blunt or straight. A file is tapered when it is thinner at the point than at the middle, and is full-tapered when thinner at the point and the heel than at the middle. Custom has also established the use of the term "taper" as a short name for "three-square" or triangular handsaw files.

BRASS

Brass is an alloy composed mainly of copper and zinc and sometimes containing small percentages of lead and iron. When zinc is present in small percentages, say about 10 per cent, the color of brass is nearly red, and the alloy is known as "red brass." An alloy containing about 20 per cent of zinc is more yellow, and a number of metals with percentages of zinc around this value resemble gold, and are known as "Dutch" metal, "Mannheim gold," and various other trade names. Ordinary brass for machine construction, piping, etc., contains from 30 to 40 per cent of zinc. A number of the brasses are known by special names, such as admiralty metal, Muntz metal, manganese-bronze (which is not a bronze, but a brass composition, bronze being an alloy in which copper and tin are the basic metals), naval brass, etc. As used in the industries, brass castings usually contain 65 per cent of copper and 35 per cent of zinc. So-called "low" brasses, which are especially suitable for hot-rolling, contain from 37 to 45 per cent of zinc. The "high" brasses, which are used for cold-rolling and drawing, contain from 30 to 40 per cent of zinc. If lead is present to an amount exceeding 0.1 per cent, the ductility of brass is decreased, and sheet brass intended for drawing should be as free from lead as possible. Brasses that must be machined, however, may contain up to 2 per cent of lead to advantage, as in that case they can be turned at high speed and a better finish obtained. Small percentages of antimony, arsenic, or bismuth in brass make it brittle and cause it to crack when rolled or drawn. In order to make brass resist the corrosion due to salt water, an addition of about 1 per cent of tin has been found advantageous.

STEEL STRENGTH AT VARIOUS TEMPERATURES

Tests have been made to determine the strength of iron and steel at high temperatures. The results show that as the temperature is increased, steel, wrought iron, and cast iron grow stronger up to a certain point. The maximum strength of wrought iron is reached at 450 degrees F., and the corresponding temperature for steel is 525 degrees F. With further increase in temperature, both the ultimate and elastic strength decrease rapidly. At 1000 degrees F., the strength of wrought iron is seriously diminished, and steel has no elastic strength. The diminution in the strength of cast iron, on the other hand, is much less in the same temperature range.

BASIC DIMENSION

The basic size of a screw thread or machine part is the theoretical or nominal standard size from which variations are made, as in the case of fitted parts which must have an allowance for providing a certain class of fit. The use of the hole diameter as the basic diameter has practical advantages in connection with obtaining different classes of fits. For example, assume that holes are to be finished by reaming, and that shafts or plugs are to be fitted into them, this being a common condition in connection with various machine-building operations. If the diameter of the hole is basic, its size, within a small tolerance, may be maintained readily by the use of proper reaming equipment. On the other hand, the diameter of a shaft or plug may be varied much more readily than that of the hole, in order to obtain the allowance for whatever class of fit is desired; therefore, different kinds of fits in holes finished by the same reamer may be obtained merely by grinding the shaft or plug to a diameter which gives the proper fit allowance. In the case of threaded holes, the tap is usually solid or non-adjustable, whereas dies ordinarily may be adjusted readily to obtain different classes of fits.

As both the hole and shaft or plug would ordinarily be given a certain tolerance, the basic dimension of a hole (except for forced fits) should be the minimum limit or diameter, there being a plus tolerance, and the nominal dimension of a shaft or plug should represent the maximum limit or diameter, there being a minus tolerance. The advantage of this method is that the minimum clearance between hole and shaft, or the "danger zone," is indicated by a direct comparison of the basic hole diameter and the nominal shaft diameter; the direction of the tolerances is such as to increase this clearance. For a forced fit, the basic hole size is the maximum diameter, the tolerance being minus, and the nominal shaft size is the minimum diameter, the tolerance being plus; consequently, the minimum fit allowance or interference between hole and shaft (or the "danger zone" for a forced fit) is indicated by a comparison of the basic hole diameter and the nominal shaft diameter. In this case the direction of the tolerances increases the interference or forced fit allowance.

PIPES AND FITTINGS FOR ACIDS

Pipes for carrying acid liquids, when made from steel, will usually last for a short time only. Wrought-iron pipes will last somewhat longer, but are not satisfactory. A steel to which 0.5 per cent of copper has been added has given good results for pipes of this kind. Valves made from ferrosilicon will resist the corrosive action of acid liquids to a considerable extent. Their first cost is higher, but their resistance to the action of the acid warrants their use.

AIR COMPRESSION

Theoretically, air may be compressed under two different conditions: Adiabatic expansion or compression of air takes place when air is expanded or compressed without transmission of heat to or from it, as for example, if air could be expanded or compressed in a cylinder made from a material that was absolutely non-conducting to heat. Isothermal expansion or compression of air takes place when air is expanded or compressed with an addition or transmission of sufficient heat to maintain a constant temperature. In actual practice, neither of these two theoretical extremes is obtainable. The work required to compress air isothermally is considerably less than the work required for compressing air adiabatically; the work required for air compression in actual practice is a medium between the work that would be required for either of the two theoretical conditions.

CANDLEPOWER

The lighting effect of a source of light is measured or expressed in candlepower. A "candle" is the unit of light intensity recognized by the national laboratories or bureaus of standards in the United States, France, and Great Britain, as well as in many other countries. Distinction is made between the mean horizontal candlepower of a lamp, which is the average candlepower in a horizontal plane passing through the luminous center of the lamp when mounted in the usual manner, as, for example, in the case of an incandescent lamp with its axis of symmetry vertical; the mean spherical candlepower of a lamp, which is the average candlepower of the lamp in all directions; and the mean hemispherical candlepower of a lamp, which is the average candlepower of the lamp in either the upper or the lower hemisphere. It is customary to rate incandescent lamps on the basis of their mean horizontal candlepower.

EFFECTIVE PULL OF A BELT

The effective pull of a belt is the difference in tension between the tight and slack sides of the belt. The approximate horsepower that may be transmitted by a belt can be determined by multiplying the effective pull in pounds per inch of belt width, by the width of the belt in inches and the speed of the belt in feet per minute, and dividing the product thus obtained by 33,000. The allowable effective pull depends not only upon the kind and quality of the belt, but also upon the operating speed; for example, the effective pull per inch of width for a single-ply belt 3/16 inch thick and of good quality, may be about 65 pounds for a belt speed of 3000 feet per minute, whereas 50 to 55 pounds should not be exceeded for a speed of about 5000 feet per minute.

PRESSURE FOR FORCED DRAFT

The pressure required for mechanical or forced draft depends upon the rate of combustion, thickness of the fuel bed, and character of the fuel used. Average conditions will usually be covered between the extremes of from 0.75 to 2 inches of water column, corresponding to 0.44 and 1.16 ounce per square inch, respectively. The volume of air or gas to be handled by the blower will depend upon whether the forced or the induced system is used. For forced draft, about 18 pounds of air is required per pound of coal, which is approximately 230 cubic feet at 60 degrees F. The higher temperature of the gases passing through the blower when induced draft is employed makes it necessary to increase this volume of air about 30 per cent, to care for the expansion.

Notes and Comment on Engineering Topics

The township of Hibbing, Minn., has acquired a motorized library containing 700 books, a librarian's desk, and sufficient reading space for twelve people. This motorized library travels in the mining sections in the vicinity of Hibbing.

In cooperation with the Chemical Warfare Service, work is being carried on by the Bureau of Entomology of the United States Department of Agriculture with the so-called war gases and other materials developed at the Edgewood arsenal. Many of these substances have been tested for the purpose of determining their availability in insect-control work and for other practical uses. A few have been found which give promise of value. A smoke candle for use in greenhouses has been developed and is being tested on a commercial scale. It seems to have a distinct place in greenhouse insect-control work.

The biography of John E. Sweet, one of the founders of the American Society of Mechanical Engineers, which has been published by the society, is a notable contribution to the biographical material available on the lives of men of science. Professor Sweet's life was one of genuine service in the engineering field, and in presenting this biography, the American Society of Mechanical Engineers believes that it is rendering a service to the engineering profession in complete accord with the ideal of service that was the prime motive of Professor Sweet's life. That men may find inspiration in the story of the life of John Sweet is the motive back of the publication of his biography.

Electric arc welding is constantly finding new applications. One manufacturer uses a recently introduced type of automatic welding machine for the construction of underground gasoline storage tanks made of galvanized iron, 7/64 inch thick, each tank having three longitudinal seams 116 inches long. These seams, in regular production, are welded at an average rate of about 16½ inches per minute, or about 7 minutes per seam. Previous methods of manufacturing these tanks required a total of 7½ hours per tank, whereas the automatic welding machine has reduced this time to 5 hours. It is evident from this that the arc welding of galvanized iron is entirely feasible, provided suitable welding electrodes are used.

In the early days of the automobile, the cylinders were bored, making the cut as smooth as possible, but no other finish was thought necessary, because the practice followed in making large steam cylinders was considered satisfactory. Later, various devices and tools were designed for finishing automobile cylinders more smoothly; and still later grinding became the almost universal practice. It is interesting to note that the grinding of cylinders for other purposes is gaining ground. Air compressor cylinders, for example, have not in the past been finished by grinding, but at a recent visit to the plant of the Chicago Pneumatic Tool Co., the practice of finish-grinding the cylinder bores was noticed. It is stated that by so doing both the volumetric and the mechanical efficiency is improved.

Twelve thousand five hundred buses and vehicles for bus use, were built and placed in service during 1924, according to a statement by Edward F. Loomis, secretary of the National Motor Truck Committee, National Automobile Chamber of Commerce, in *Bus Transportation*. This fact, together with the estimate of 2,500,000,000 passengers carried in old and new buses in 1924, indicates, the writer points out, that the bus is fast assuming a major position in our transportation system. When added to buses in operation prior to 1924, these new vehicles bring the total number of buses in service in the United States and Canada on January 1, 1925, to 53,000. The gain during 1924, therefore, represents approximately 25 per cent of the total now in use. Figures obtained from bus operators forecast a corresponding growth during the present year. That electric railways realize the possibilities of the bus as a transportation medium is attested by the fact that while only 1,200 buses were used in this field on January 1, 1924, no less than 3,000 were used on January 1, 1925, representing an increase of 150 per cent. Three steam railroads are also operating buses in common carrier service.

Since the inauguration of the moving picture, the problem of producing talking motion pictures has been considered by many inventors. According to *Engineering*, Dr. Lee de Forest has recently achieved considerable success with a new type of film known as the "phonofilm," in which the sound record is actually carried on the same film that carries the pictures. Hence, in reproducing the pictures and the sound absolute synchronism is always assured. The method has been demonstrated in London in connection with the recent Physical and Optical Societies' Exhibition. The interesting demonstrations of the phonofilm comprised a telephone monologue, a banjo solo, a dance with accompaniment, a concert by thirty-five instruments, a violin solo, and a speech by President Coolidge delivered in the grounds of the White House. The reproductions were highly appreciated by crowded audiences and, although not perfect, were remarkably good, considering the many energy conversions involved, the enormous amplifications needed at different stages, and the present imperfections of the various apparatus. The active development work is being carried on in London.

Numerous references have been made in the daily and technical press to the Flettner rotorship developed in Germany, by means of which sails are eliminated and rotating vertical cylinders are substituted, the rotation of which creates a certain vacuum and thereby permits the pressure of the wind to propel the vessel at a satisfactory speed. Apart from its practical value, the Flettner rotorship embodies a most interesting scientific development, based as it is on purely scientific experiments. At present, speculation centers mainly upon its practical value and to what degree it will influence the future development of sea transportation. There have been statements to the effect that there is an extensive building program under way in Germany of ships of this type, but this information, according to *The Transatlantic Trade*, does not correspond with actual facts, as no definite plans have been made to put the invention to practical use. In the trials, the rotorship has proved quite satisfactory, but it is doubtful if ships provided with this means of propulsion alone would be practicable. On the other hand, a combination of propelling machinery and "rotor-sails" raises the question of the action of the wind upon the rotating Flettner cylinders of a vessel that is also driven by a propeller. This question will be investigated within the next few months.

The British Metal-working Industries

From Machinery's Special Correspondent

London, March 16

THE general outlook in the metal-working industries continues to be hopeful, and most sections are making progress. In areas such as Manchester and Glasgow, where the results of the general improvement were not felt so early as in the Midlands, there are many indications of increasing confidence. The machine tool trade prospects in these and other centers show a noticeable improvement. In some cases, particularly in the Midlands, the continued requirements of the automobile industry are largely responsible for the activity of the machine tool shops, but there is now frequent evidence that other important industries are at last taking steps to bring their machine tool equipment up to date.

In the Yorkshire area, radial drilling machines, makers of which are well represented in this county, are well to the fore among orders now going through, while boiler-plate drilling machines and railway car wheel boring machines, axle-ending machines, shapers, and planers are all in fair demand. In the Birmingham district, machine tool makers are well occupied with machines for the lighter manufacturing industries. As previously indicated, the automobile industry is responsible for a large proportion of the work in hand in several large shops. Much of the work is of an urgent nature, and it is not yet known what the prospects are for a repetition of orders. Such work has, however, tided over some expansive gaps in the output of more normal lines of production.

In the Manchester area, machine tool shops continue to work below capacity, although the orders in hand are in many cases keeping the reduced forces busy. Makers of standard types of machines generally have less work than those prepared to build special types or who have a monopoly of a particular type of machine. In this area the competition of Belgium in woodworking machinery is somewhat keenly felt. There are now more than twice the number of woodworking machine builders in the district than was the case ten years ago, and with this must be coupled the fact that the export trade in woodworking machines, which ten years ago represented 80 per cent of the output of this industry, has not yet been recovered to any appreciable extent, and the demands of the building industry, though increasing, are not likely to make up the difference.

The West of Scotland machine tool industry is now probably in as good a position as any other local industry, and is much better off than for some years. Manufacturers are being forced to bring their plants up to date, in order to cope with foreign competition, and in some works a clean sweep is being made of obsolete equipment. This, together with a partial revival of foreign trade and the spending program of the associated railway companies, has helped to keep local works moving.

Overseas Trade in Machine Tools

The official trade returns show that the exports of machine tools increased during January, both in tonnage and value, the tonnage rising from 1039 in December to 1109 in January, with corresponding values of £127,330 and £135,382. More significant than the actual increase for the month was the fact that it represented a continuation of a steady improvement that has been noticeable for the last ten months. The spasmodic peaks and depressions that have characterized these returns for the last three years appear definitely to have given place to a much needed degree of stability.

The imports of machine tools during January reached a tonnage greater than any monthly total for the last four years, the figures being 453 tons, with a value of £76,354. The corresponding figures for December were 348 tons with a value of £54,616. The value per ton of imports in January was £169; the value per ton of exports was £122. Although the figures for prewar years can in no sense be considered normal, it is interesting to note that the exports for January were 87 per cent in tonnage and 174 per cent in value of an average month during 1911 to 1914, while imports were 164 per cent in tonnage and 285 per cent in value of the prewar figures.

An analysis of the countries to which British machine tools were exported during December, shows that India was the best customer, buying tools to the value of £24,000; Russia and Portuguese East Africa were next with £14,000 each, after which came South Africa and Australia with about £10,000 each, France with £7000 and New Zealand and the Argentine with £4000 each. America, during December, sent us machine tools to the value of £36,000, Germany being next with £14,000, and Switzerland third with about £5,500.

General Engineering Field

There is more confidence in general engineering circles, but everyone connected with the industry realizes that there is a long steady climb ahead. In some localities one group of branches is busy, while in neighboring sections the chief activity of the moment may be concentrated on other classes of work. Constructional engineers in most districts are well occupied, and this in itself is an excellent sign; the same remark applies to millwrights who also are experiencing a fair regularity in the orders that are coming to hand. There is an improving demand for boilers and boiler fittings, while crane makers, particularly those who build the smaller types, are fairly busy. Business among textile machine manufacturers is slow, but a bright spot is to be noticed in some fairly substantial orders for Scandinavian countries. Makers of railway rolling stock continue to be fairly well employed, and there has been a slight improvement noticeable in the locomotive building industry.

The gathering momentum in the engineering industry is throwing into strong relief the shortage of skilled operators in many branches. The long slump, relatively low wages, and other factors have strangled the supply of trained men. The solution is not easily found, and in any case some years must elapse before the benefits from any steps that may be taken are felt.

The Automobile Industry

Activity in the automobile industry remains unabated. The season's trade is developing rapidly and forces and equipment are being augmented. One well-known light car maker has just installed forty new manufacturing-type chucking lathes, besides substantial additions to their milling, drilling, and grinding equipment. Motorcycle and bicycle makers are embarking on production programs that represent an output about double last year's figures.

Shipbuilding

The relative amount of new tonnage booked, compared with that being launched, continues to be a disquieting feature of the shipyards. This inequality cannot continue much longer if any work is to remain in the yards. During the first two months of this year the tonnage launched on the Clyde totalled 69,502 tons for 20 vessels, as compared with 47,524 tons for 22 vessels in the first two months of last year. These figures compare unfavorably with 93,431 tons launched in the first two months of 1921, which represented a record.

Current Editorial Comment

in the Machine-building and Kindred Industries

WORTH-WHILE SAFETY WORK

Scores of articles have been written about the need for safe working methods, safeguards, and the training of employes to avoid accidents. But what are the results where efforts have been conscientiously and persistently made?

The record in the plant of Henry Disston & Sons, Inc., of Philadelphia, Pa., answers this question. In 1916, with a smaller working force than that employed at present, more than 300 men were injured in the Disston plant through accidents causing losses of one or more days' time. The total number of working days lost was 5471.

Then the company engaged in active efforts to prevent accidents. Safety committees were appointed for each department, working in close cooperation with the executives of the company, and every operation that involved the personal safety of the workers was given careful attention. As a result, in 1924 only 71 men suffered from accidents causing losses of one or more days' time, and only 1174 working days were lost through accidents; a reduction of more than 75 per cent in the number of accidents and the number of days lost.

In most cases these safety campaigns have been started for humanitarian reasons. Plant officials have recognized the appalling suffering and hardship resulting from accidents that greater care might have prevented; but in carrying out the campaigns they have found that this work is also well worth while from a purely commercial point of view, and is profitable both to the employer and the employe. Fewer working days are lost, there is less interference with the normal running of the plant, there are fewer compensation claims to be adjusted, and the relations between employer and employe are greatly improved through the opportunities for cooperation and contact that the system of safety committees offers.

* * *

SPECIALIZATION IN ENGINEERING

A specialist might be defined as a man who knows a lot about one subject, although such a definition often would be misleading. Competent specialists, such, for example, as designers of a certain class of mechanical apparatus might be compared with a searchlight which is arranged to focus thousands of candlepower upon a small area. A specialist deserving of the name must have a broad knowledge which can be focussed upon his special work whenever necessary.

Suppose, for example, that a designer has specialized in tool equipment for turret lathes and automatic screw machines, but has also followed closely the applications of various other classes of manufacturing equipment. One possessing this broader knowledge does not attempt to design tool lay-outs for a given job until he has first considered other machines that might be capable of doing the same kind of work. In almost every shop will be found examples of notable savings that are the direct result of using the right machine for the job. Such a machine may be quite different from the type ordinarily employed, as, for example, when a power press is used in producing parts from sheet stock which according to customary practice are machined from "the solid," but at a much slower rate. The tool equipment specialist may not be an expert in die design, but, nevertheless, may understand enough about press work to recognize its general possibilities and make intelligent recommendations. This same principle applies to various other classes of manufacturing equipment.

In automotive shops, particularly, we find many highly specialized machines which are designed for producing one part or for one series of operations only. The designers of such machine tools, as a rule, are men who understand the general subject of machine-building practice, and it is this general knowledge frequently that enables the designer to see the possibilities of a special machine in one instance, or its limitations as applied under other conditions.

* * *

KNOWLEDGE ESSENTIAL TO PROGRESS

To get something for nothing seems to be a universal desire, although repeated experiences teach that usually it is necessary to pay for value received, but payment in the coin of the realm is not always required. In fact, a most valuable asset, especially to the younger readers of MACHINERY, may be acquired chiefly by expending *time* rather than money. There is nothing original about this thought, since it pertains to the conversion of spare time into useful knowledge. That "knowledge is power" is a truism that has received general recognition. Some self-evident truths appear to require the greatest amount of publicity, merely because they are so commonplace as to be overlooked.

A toolmaker in a recent letter to MACHINERY says he has been convinced that "a man must keep up with new developments." This idea of "keeping up" is right to the point. If engineering and manufacturing practices were all reduced to a fixed standardized basis, we would not need to be concerned about developments. But progress connotes change in both methods and equipment, especially in a highly technical business, such as designing and building mechanical apparatus. Consider, for instance, what has been done toward perfecting machine shop equipment during recent years. When there was greater dependence upon skill and less upon the use of efficient mechanical devices, problems connected with the selection and use of manufacturing equipment were simplified accordingly. But in these days there are so many changes and improvements that the progressive young mechanic or engineer soon finds that a knowledge of them is essential to progress.

* * *

INSPECT YOUR ELECTRIC MOTORS

In a paper read some time ago before a production meeting of the Society of Automotive Engineers, L. A. Blackburn, plant engineer of the Olds Motor Works, Lansing, Mich., said that with the increasing popularity of the individual motor drive, a difficulty frequently met with is that of motor "burn-outs." In such cases the machines must be shut down until the motor can be changed, always causing delay in production. "Burn-outs" and other motor troubles could be avoided to a great extent by the right kind of inspection of motors and the proper system of cleaning. In a shop formerly employing four armature winders, who seldom were able to rewind the armatures as fast as they burned out, a proper system of inspection and cleaning of the motors reduced the number of "burn-outs" so that now one winder can take care of all the work.

An electric motor will not run indefinitely without care. Frequent cleaning is necessary, and regular inspection to prevent more serious trouble from developing, is a prime requisite. In one shop where 300 motors are in use, one electrician and a helper take care of them, and the number of burned-out motors has been reduced to an average of about three a month.

Let Us Face the Facts

By WILLIAM A. ROCKENFIELD, General Manager, Baldwin Chain & Mfg. Co., Worcester, Mass.

WILLIAM A. ROCKENFIELD has had an extensive experience in the machine-building field, having risen from apprentice through the intermediate steps of machinist, foreman, superintendent, chief engineer, and assistant manager, to his present position of general manager of the Baldwin Chain & Mfg. Co. During his experience he has been engaged in the building of various classes of equipment, including baking machinery, steam engines, and automobiles, and in the making of chains. The unusual success that he has had in handling men has been based on the belief that all men respond to fair treatment. He considers his position an obligation as well as an opportunity, and his constant aim is to help and inspire others to get ahead.

SINCE the latter part of 1920, men engaged in industries of almost every description have been complaining that business is poor. To be sure, there was a severe depression in 1921 and in the early part of 1922; but since the fall of the latter year, the total output of the industries of the United States, with a few exceptions, has been very large—at times greater than at any previous period. Why then is it that so many men engaged in business still feel that the volume of business in their particular case is unsatisfactory?

The answer is this: Practically all our industries are over-expanded. The total capacity of the plants in the United States manufacturing a given product, in many industries, exceeds normal demand. Many manufacturers have gone on building new plants and adding to old ones without due consideration of the total capacity of the plants in their respective industries for making the kind of goods they themselves produce. They have apparently failed to make a careful analysis of the relationship between total capacity and the quantity of a particular product the nation may be reasonably expected to absorb; in other words, they have not considered the necessity of allowing demand to catch up with present capacity.

Likewise, some manufacturers, finding a decreased demand for the product that was formerly their major staple (due to the very situation described) and therefore left with an over-capacity, cast about for something else to manufacture and augmented their line with another article—adding more producing units to those already in existence and thus aggravating the situation in some other branch of the industry. Thus we find a vicious circle which does not make for the healthy growth of the industry as a whole. The result is that with a perfectly healthy and normal market for most commodities, our manufacturers still find themselves running their plants at only 50, or 60, or at best 70 per cent capacity.

The Constant Drive for an Increasing Volume of Business

As a nation, we have become so used to the idea of expansion that we believe that each year we should do a much larger volume of business than we did the previous year, both as regards our total national turnover and our individual factories. Large increases in the volume of business were possible as long as this country itself was in a state of definite expansion of its resources, and when the population, due to an unlimited immigration from Europe, increased by a large percentage annually.

However, these conditions have changed: The immigration has been limited to a figure where it barely balances the number of former immigrants that are returning to their native countries; most of the vast areas of our territory have practically been opened up; there are no great railroad projects to look forward to, such as characterized the last few decades of the past century; and on the whole, we have settled down to a more normal condition, requiring stability, rather than spectacular expansion.

As business men, however, we have not yet grasped the situation. We still believe that each year should show a substantial increase in the volume of business, and that the country can be made to continuously absorb all that can be manufactured. In many instances we have reached out for an expanding volume, rather than for an improved quality. We are inclined to measure the success of a business by the figures expressing our total sales, rather than by the leadership that we occupy by virtue of the quality of our product. We assume that markets can be forced by high-pressure methods without due regard for the fact that progress by unstable means leads to short business life.

Here and there we find some exceptional men refusing to follow the procession and proceeding with the same caution as our European cousins, who invariably refer with pride to the "number of years they have been in business," as opposed to the size of their business; but these exceptions are rare. Such men do not measure their success in terms of greater plants and greater volume of business, but in terms of quality of product. Their aim is to produce the very best article that can be made of its kind, thus laying a firm foundation for the building of a business that will endure.

The Waste of Unintelligent Competition

There is such a thing as unintelligent competition—through the use of methods that have a final unhealthy reaction on the industry as a whole. With the over-expansion of our plants in almost every manufacturing field—shoes, phonographs, machine tools, drills, locomotives, automobiles, textile machinery, cotton mills, and so on through practically the entire range of industry—has come a keener competition than ever before, accompanied by extremely wasteful, and sometimes even unethical, practices. When there is not business enough to fill, or even partly fill, everybody's plant, it is only natural that each active manufacturer should reach out to get, not only what might normally be called his share of the business, but also a share of the business of his competitors.

The individual manufacturer can increase the volume of his business in two ways only: he must either create an entirely new demand for his product, or get customers away from his competitors. The most commendable way in which to get more business is to create a new demand by showing new ways in which a product can be advantageously used. Unfortunately, this is the hardest method of obtaining new business and one that can only be used when business is healthy and making sufficient profit to justify the expense attached to the experimentation, laboratory tests, and other development work necessary. Reference to statistics of the earnings of corporations hardly justifies the belief that this situation holds true at present.

It always seems to be much easier to try to get your competitor's business. This can be done in two ways: First, by stimulating a normal and healthy growth of the indus-

try—accomplished by so improving your product that it is superior to that of your competitor. This is the healthy and permanent way. Second, by selling to your competitor's customers at a lower price than that quoted by him, thereby obtaining the business at a sacrifice. The unfortunate part of the latter method of obtaining business is that your competitor is probably equally capable of getting your customers by the same means, which at best yields only a temporary and seldom a permanent advantage. There have been very few instances where advantages gained by other than substantial means resu ted in permanent leadership. The result is a demoralization of the commercial conditions in the industry without any appreciable gain on the part of anyone. Yet, this is a condition existing now in many industries due to the unfortunate over-expansion fostered by the abnormal war demand and the speculative boom immediately following the war.

Is there a Remedy?

There is no cure-all that could be applied to any such abnormal condition in business as now exists, but the first step toward a more normal and stable basis is to fearlessly and honestly face the facts. Those who expect to continue in business successfully must be willing to see the conditions surrounding them exactly as they are, and settle down to a method of conducting business that is in harmony with the situation as it exists.

We cannot by magic eliminate our present overcapacity for producing goods for which there is not a sufficient normal demand, but we can take every step toward eliminating waste. Probably our greatest waste in the manufacturing field at present is to be found in excessive overhead. We have become so used to methods of management that increase the overhead that it is difficult for us to see the possibility of reducing this item. The writer would advise any manufacturer who thinks that overhead cannot be reduced to go down to his own plant on a holiday, visit it as if he were an outsider, and look into it with the cold eye, of, say, his banker.

There are two ways to conduct a business so that it will weather a storm: (1) To use high-pressure methods to force sales, which can usually be done only at the high cost that nearly always attends high-pressure methods of any kind; or (2) to reduce expenses, making the sails fit the cargo, battening down the hatches, and riding out of the storm. The latter method is the one advocated by the author of the present article. In addition, he points out that it must be remembered in these times that it is sometimes real economy to spend money for cost-reducing equipment, because then when business again becomes normal, one will be in a position to take full advantage of the opportunity for profitable operation.

In looking over the business in this way, forget that this particular office is occupied by John Smith, and that this job is held down by Fred Brown. Irrespective of personalities, examine what is needed to keep the business going in the most profitable, efficient, and economical manner. Base your conclusions on business conditions that actually exist rather than on hopeful or too optimistic futures. Work with the facts, and make every dollar do its best work.

Scrutinize every job; discover if it is a duplicate or simply a convenience; visualize its importance or lack of importance by weighing carefully just what would happen if it did not exist; consider whether it couldn't be simplified so as to get down to real essentials, and doubled up with another simplified position, thus perhaps using one man for both instead of two.

Find Out if Your Business is Over-systematized

Consider carefully your numerous files of cards and data being accumulated daily, reflect on just how much is red-tape and how much is really needed and actually used to guide and govern the business. Bear in mind that entries and tabulations and records that simply repose in files and are seldom consulted cost money and that the tendency, especially in a highly departmentalized or systemized business, is to let a great amount of "paper" work accomplish a very small practical result. There is also a tendency for each separate office or department or division to become "sufficient unto itself," and to duplicate effort and equipment with the increased personnel necessary to sustain it. Two officers or clerks only half busy on work that is essential is just twice the overhead of one.

In many instances, the pressure for reduced costs starts on the production end. Cutting wages usually accomplishes little; concentration on overhead and making sure that essential service is rendered in proportion to numbers produces much. There is a possibility that the fact may be forgotten that for each dollar of executive overhead, the production and sales end must produce or sell approximately ten dollars worth of goods. In other words, reducing overhead by $1,000 may be equivalent to the profit on a $10,000 order. It is well to keep that fact in mind when analyzing overhead with a view to cutting operating costs or setting budgets. We may make headway by going back to something that is out of style—less system and more "wits."

Analyzing your business in this way often makes it evident that changes are advisable. These changes are disagreeable tasks and take courage; they should be made by the executive head having the real responsibility. That makes him "get down to brass tacks"—efficiency and economy are but words unless made vital by action. After that it will be necessary to pass the responsibility for the program to the various department heads. Right at this point is developed the additional efficiency that always comes from the self-elimination of those who cannot courageously face facts and put their shoulder to the wheel when some of their own pet theories are involved, for the good of the business as a whole; for maximum efficiency in any organization can only come when each key man in it assumes a great measure of personal responsibility, and develops thereby a self-reliance that assures its continuance.

After this is accomplished, scrutinize the manufacturing processes and determine upon the greatest inefficiencies existing; then make an earnest effort to eliminate them. This, too, takes equal courage. It will require the spending of money at a time when it might seem more advisable to preserve the financial resources; and it will require a high degree of judgment to spend it in the right direction. New equipment may be required to replace old and inefficient machinery. The best time to do this is when business is not too active.

The guide and rule in this connection is to discover if new types of machines and tools have been developed that will perform your work at costs that over a reasonable period will justify the capital invested. The kind of period we are now passing through is an incentive to the machine tool manufacturer to produce tools that accomplish this end. Since it is generally conceded that labor costs will remain at least at the present levels, there is but one other solution—more efficient equipment and processes that will increase the output per man. When business is brisk, replacements of this kind are likely to interfere with production, and hence become more costly than if attended to at a slower season; and as a matter of fact, that is the time when they are most needed.

Always Respect your Competitor's Ability

Never assume that your business is being run in the most efficient manner, and that your competitor is inefficient, less pushing than you are, or less capable. Any business man who takes comfort in the fact that he knows his

competitor "isn't making any money" is simply "whistling in the dark." And if he imagines that he can continue to countenance inefficiencies in his own plant and pass excessive overhead and other waste to the customers in his prices, because his competitors are no more efficient than he is, he is not likely long to hold his own in business. The safe way is to assume that your competitor's plants are run in the most efficient manner possible, and that the competition you have to meet is a competition of people as able as you are.

How to Measure Efficiency

For your own best interests, never assume that either your plant or any individual connected with it is 100 per cent efficient. If you expect perfection, either in your plant or in the men responsible for its output, you will meet with disappointment, and you will never be able to obtain to the full extent the percentage of efficiency of which your plant and your associates are capable. Many executives forget this important principle.

When you look for perfection in an individual—for 100 per cent efficiency—you exaggerate the smaller inefficiences and you underestimate the sterling qualities that may be present. In so doing, you fail to recognize and encourage the possibilities of your associates, while you are censoring them and finding fault with their shortcomings. Instead of increasing their efficiency, you will decrease it by these methods.

The same is true of a plant. Increase its efficiency and productive capacity along the particular lines on which your plant possesses certain distinct advantages, either in skilled personnel or equipment; but do not expend too much money and energy in costly systems for remedying small defects which, even if they could be eliminated, would not materially increase the returns of your plant. Sound business judgment is necessary in measuring the real value of both men and equipment, and particularly "systems." Many a plant has spent more on maintaining systems to prevent small losses than the total of these losses would have amounted to.

The Importance of Careful Selection of Salesmen

The selection of salesmen has perhaps never been so important as it is today. Education, personality, and intelligence are a necessary equipment of any really successful salesman under present competitive conditions. Pick men who are producing steady, consistent results, rather than the brilliant fellows who "put it over in flashes." The type of salesman who is honest and fearless enough to say "I don't know, but I will find out"; who does not make up his mind that the "Jones Company is running short time at present and it would be a waste of time to go there"; who can realize that over a period of time the orders are in direct proportion to the number of calls; and who is constantly on the job—that salesman gets the business, because there is always something being bought.

Many manufacturers are now beginning to recognize the fact that the time to replace their equipment to the greatest advantage from every point of view is when business is not too brisk. The salesman, even if he is not able to get the order, is almost certain to get more of a hearing when business is reasonably quiet, and he can lay the foundation for a sale to be made later on. It is important, therefore, not to slacken the sales effort when business seems quiet and sales are few and far between, and it is equally important to do everything possible to keep up the courage of the sales force at such times.

Last, but not least, let your salesman go out with the conviction that he can face competition with an article of real merit, and that his sales will be due to the quality of the product that he sells, coupled with his diligence. Never in either his or your great desire for business allow him to make ill remarks about your competitor, or take an unfair advantage—it hurts the morale of the great business you are engaged in.

MACHINE TOOL MEETING IN CHICAGO

A very large number of the members of the American Society of Mechanical Engineers belonging to the Chicago Local Section are vitally interested in machine shop practice, and for that reason a special machine tool meeting was arranged by this section of the Society, March 11. Two sessions were held, one in the afternoon and one in the evening, and it is planned to hold a similar machine tool meeting in Chicago every year during the month of March. The afternoon session was held in the Auditorium of the Western Society of Engineers, in the Monadnock Building, and the evening session was held at the City Club, preceded by a dinner. At the first session the following papers were presented: "Trend of Machine Tool Design from User's Standpoint," by J. R. Shea, assistant superintendent of development, Western Electric Co.; "What We Want in Machine Tools," by Robert R. Keith, chief engineer, Motor Trucks and Busses, International Harvester Co.; and "Die-cast vs. Machined Parts," by S. A. Hellings, vice-president, Stewart Mfg. Co.

The evening session was devoted to a symposium on the finishing of plane surfaces. An opening address was made by Hugo Diemer, chairman of the machine tool committee, and director of industrial courses at the LaSalle Extension University. Four papers were then presented, as follows: "Heavy Millers," by A. H. Lyon, chief engineer, Ingersoll Milling Machine Co., Rockford, Ill.; "Planers," by Forrest E. Cardullo, chief engineer, G. A. Gray Co., Cincinnati, Ohio; "Milling Machines," by W. W. Tangeman, Cincinnati Milling Machine Co., Cincinnati, Ohio; "Disk Grinders," by F. F. Gardner, vice-president, Gardner Machine Co., Beloit, Wis.

This is the first machine tool meeting that has been held by the Chicago Section of the American Society of Mechanical Engineers. It was distinctly successful. There was a good attendance, and the interest taken by those present in the subjects presented was evidenced by the fact that after the meeting was over they lingered for a considerable length of time, talking over the different subjects presented with the speakers and with one another.

* * *

GEAR MANUFACTURERS' MEETING

At the ninth annual meeting of the American Gear Manufacturers' Association to be held at Hotel William Penn in Pittsburg, Pa., May 6 to 9, inclusive, an important paper will be read by F. W. England, vice-president of the Illinois Tool Works, Chicago, Ill., on the subject, "What are the Future Possibilities in Gear Manufacturing Equipment?" Another paper that will be of considerable interest will deal with "The Gear Industry on the Pacific Coast." This paper will be presented by Frank B. Drake, president of the Johnson Gear Co., Berkeley, Cal. The extremely rapid growth of the industries on the Pacific Coast makes any presentation of the development of the industries in this section of the country of more than usual interest.

* * *

THE AUTOMOBILE INDUSTRY

The automobile production in February, according to the National Automobile Chamber of Commerce, totalled 277,600 cars and trucks, an increase of about 15 per cent over January. It is well known that both manufacturers and dealers have been very cautious in building up a stock of cars, so that at present production is practically completely absorbed by actual sales. In some instances delivered to customers are now several months in the future. It is likely that there will be a steady increase in production until the peak is reached early in the summer. This increase is not expected to be very great, but on the other hand, it is not expected that there will be any appreciable falling off after the peak has been reached. The reports from almost every part of the country are favorable. There have been rumors relating to large mergers in the automotive field, but *Automotive Industries* says these are without foundation.

AUTOMOBILE BUILDING IN ENGLAND

With a view to meeting the unusually large demand for a low-priced light car, the Morris Engines Ltd., Coventry, England, have taken some very important steps in the development of unusual production methods. Our English correspondent states that to achieve the desired results this company is designing and constructing what may be called "continuous" machines, some of which are already in operation. It is in the type of machines used that this British development differs from American practice. The lay-out of the plant is arranged around the cylinder block, which, besides being the largest and heaviest and most costly part of the engine, may also be regarded as the backbone of the power unit. All other parts, so to speak, flow to meet the cylinder block, which does not touch the floor from the time it leaves the foundry until it is part of the engine.

The cylinder-block machine is a distinct departure from ordinary practice. It is 181 feet long, 11 feet 4 inches high, and 11 feet at its greatest width. It weighs upward of 300 tons, and is capable of finishing cylinder blocks from the casting to the finished job (including bearing blocks, crankshaft bearings and all studs) at the rate of one every four minutes, it being understood, of course, that the total time a block takes to pass all operations is 224 minutes. There are 53 separate operations. Eighty-one electric motors with a combined rating of 267 horsepower are employed.

In the past, on an output of 100 engines per week, it took four men occupying 53 square yards in area, using 3.5 horsepower, to produce one engine and gear-box. Now, on an output of 1200 per week, 1.83 men occupying 15.6 square yards area, and using 1.27 horsepower, produce the same articles, the time in both cases being the same.

DRILL JIG FOR MALLEABLE-IRON CASTING

By H. F. RUEHL

The jig shown in Figs. 1 and 2 was designed for use in drilling rough malleable-iron castings. The hole drilled at *A*, Fig. 1, in the part shown by heavy dot-and-dash lines is not required to be accurately positioned with respect to the holes at *B*, but must be accurately located in relation to the tapered hole *C*. The gage-blocks *D* and *E* serve to locate the holes *B* in the correct position.

In loading the jig, it is only necessary to set the casting in position and close lever *F* which is shown in the open position in Fig. 2. The blocks *D* and *E* automatically locate and force the piece against pin *P*, Fig. 1. As spring *G* is much stronger than spring *H*, the block *D* is forced back until the casting comes in contact with the block *E* on lever *F*. The force exerted by spring *G* on the work is sufficient to hold it firmly in place while the drilling operation is performed. The latch *J* serves to hold the lever *F* in the closed position. Rockers are provided at *K* to facilitate turning the jig over so that the work can be drilled from both sides. It will be noted that the bushing plate *L* is attached to lever *F* and does not interfere with the loading of the jig.

The guide bushing for hole *A* is held in a member secured to the locating pin *C*, and automatically moves with the latter member. This arrangement compensates for any variation that may exist in the castings. Pin *C* and block *D* line up the casting with center line *M*, and pin *C* and block *E* line it up with center line *N*. The body of the jig is made of cast steel. It is light in weight, compact, and easy to handle.

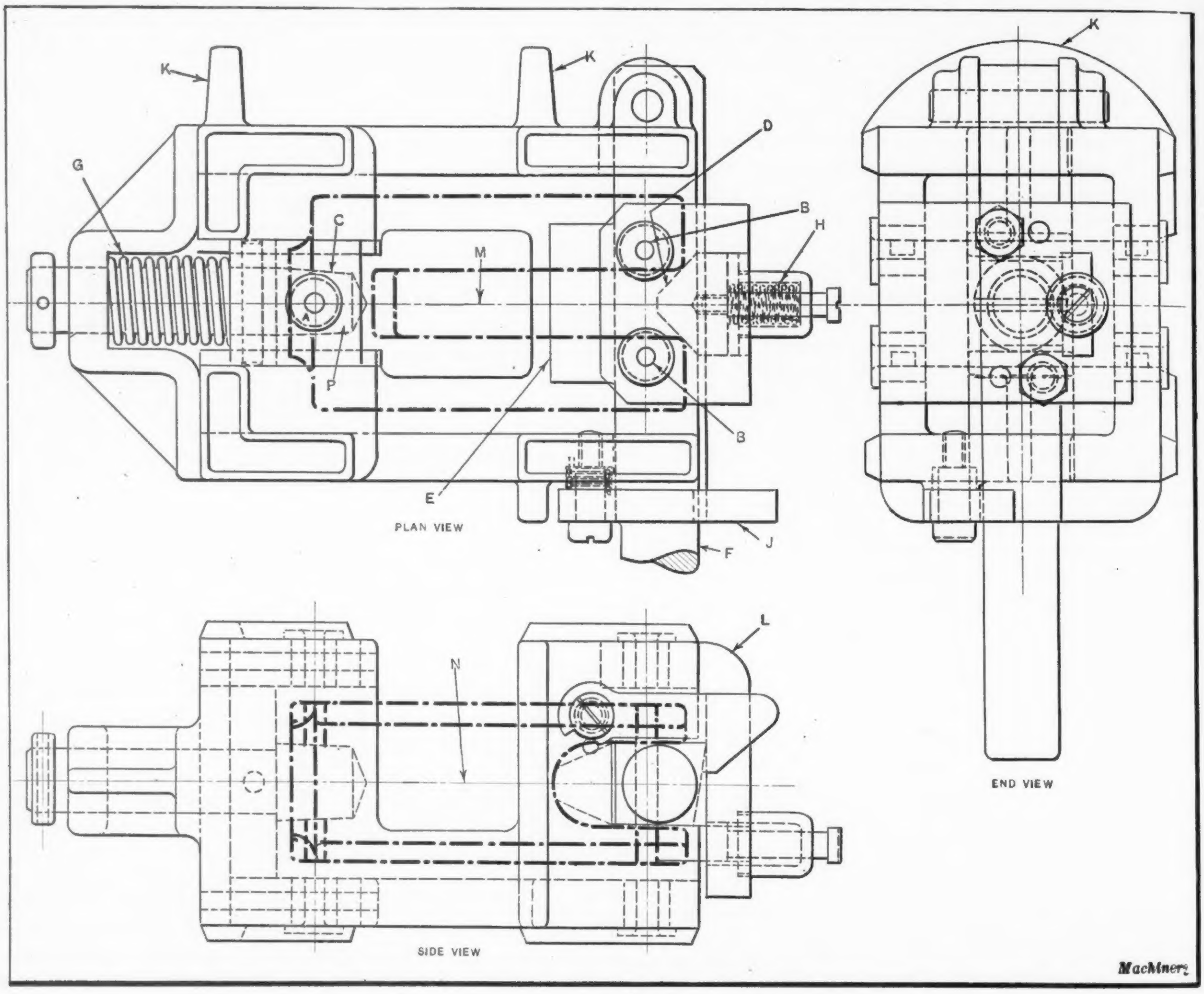


Fig. 1. Special Jig used in drilling Malleable-iron Casting

THE SUCCESSFUL FOREMAN

In an article by Louis Ruthenburg, general manager of the Yellow Sleeve Valve Engine Works, East Moline, Ill., in *The Foremen's Magazine*, the official organ of the Ohio Federation of Foremen's Clubs, it is pointed out that not long ago the foreman was merely the best workman in the group—the master mechanic. Now he must be the business manager of his department, and business management requires a knowledge of many things not necessarily learned at the bench or at the machine. An appreciation of this fact will lead to a better and broader training, largely because the foreman himself realizes his own needs.

The problems that meet the foreman may be resolved into three different groups: (1) Technical, requiring an answer to the question "Will it work?"; (2) economic, requiring an answer to the question "Will it pay?"; and (3) psychological, involving the human side and requiring the enlisting of enthusiastic cooperation. Most of a foreman's working life before he becomes a foreman is devoted to the first phase—the technical problems. "He was made a foreman, in most cases," states Mr. Ruthenburg, "primarily because of his knowledge of the job—his technical knowledge—the 'know how.' This serves him not only directly, but indirectly in establishing his high standing with his subordinates—and here we begin to merge the technical into the psychological or the human side of the problem.

"Next he encounters the economic phase of his work. He may have the opportunity of recommending an elaborate and expensive machine which reduces the direct labor involved in an operation. But will it pay? While the direct labor payroll is reduced, the machine goes on the payroll in terms of depreciation—and in dull times it cannot be 'laid off.' Where is the economic balancing point between saving in direct cost and extension of capital charges? He begins to realize that 'overhead' is made up of certain definite expenditures and that in some cases high overhead with low direct cost may bring about the best economic result, while under other conditions the reverse is true. These are things that were not dreamed of when he worked at the bench or at the machine.

"Every successful foreman at some time awakes to a realization of the fact that where in the old days, before he became a foreman, he dealt with the simple materials of his trade, which are subject to a few easily controlled variables—the steel under a tool or in a fire; the material between lathe centers; the mechanism of a press—his success and advancement now depends to a very great degree upon his control of human nature in the men under his control. Then he realizes that his apprenticeship as a foreman only started when he gained recognition as the master in his group—that he had only his second wind when he acquired an understanding of the dollars and cents relationship—and that he may profitably spend the rest of his life studying men."

* * *

METHOD OF RELIEVING INSERTED-BLADE TAPS

By CHARLES KUGLER

The method of relieving taps and reamers described in this article was used with very good results by the writer while employed as toolmaker by a concern engaged in the manufacture of hot-water boilers for heating purposes. The reamers and taps used in producing this equipment had a taper of 3/4 inch per foot and ranged from 2 to 4 inches in diameter. As the lathe on which the tools were made had no relieving attachment, it was the practice to file the clearance or relief by hand. However, this procedure was so expensive that the writer was led to develop the following method.

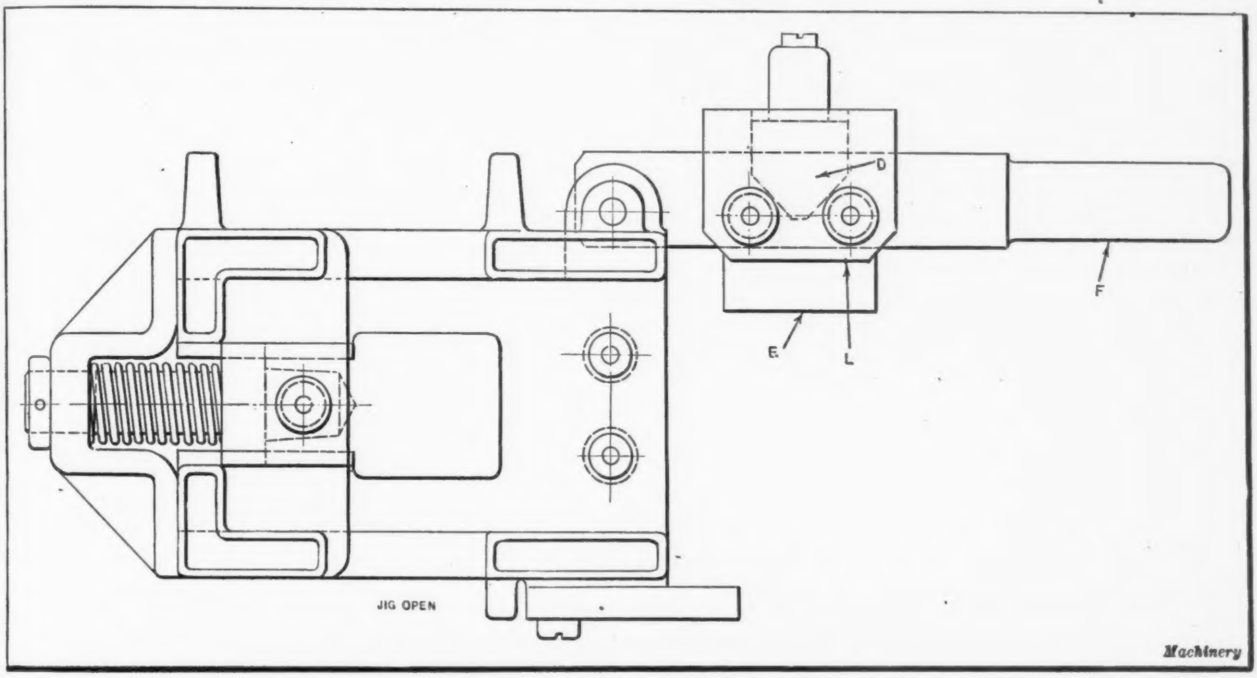


Fig. 2. Jig shown in Fig. 1 with Clamping Lever swung Open

The bodies of the taps for all sizes were made the same except for the difference in diameter. The slots for the inserted blades were all of the same width and were cut to the same depth. The blades for a given size of tap were made in a body one size smaller than the one in which they were to be used. That is, if a 3-inch set of blades was required, they were put in a 2½-inch body for the chasing or cutting operation. It is obvious that the curvature of a set of blades machined or cut in a 2½-inch body is less than if turned in a 3-inch body. The smaller curvature of the blades thus made provides sufficient clearance, and the cutting action is the same as that of blades on which the clearance is filed by hand.

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An important event in transportation during the past year was the development of a design of electric railroad locomotive which operates from alternating-current feeders but uses direct-current driving motors. A practical oil-electric freight locomotive was also built and tested in actual service under a variety of operating conditions. The adoption of light-weight equipment and multiple car operation for street railways was also extended.

CONDITIONS IN THE RUSSIAN MACHINE-BUILDING INDUSTRIES

By J. A. MASSEL

What are the present conditions and general trend in the machine-building industries of Russia? This question has been asked of the writer, who has recently returned from a ten months' stay in Russia as the representative of several American manufacturers. A few impressions based upon observations in many plants and in different industrial centers will be presented to MACHINERY'S readers, the aim being to deal tersely with a few of those points that are likely to be of the greatest general interest.

There is considerable activity at the present time in the manufacture of machinery—particularly agricultural machinery, locomotives, pumps, and industrial trucks. Automobiles are also being made on a small scale, but these are intended chiefly for business purposes, as the manufacture of pleasure cars is not regarded favorably by the government. This decided advance in machinery manufacture is due to more settled conditions, as regards both available funds and the adoption of a more definite constructive program.

Prior to this recent period of activity, manufacturing plants were in a chaotic condition, due to lack of equipment and to inefficient management. Now many of the shops and factories have been equipped with modern machine tools, which are mostly of American make, and the plants are being organized along American lines.

Plants belonging to various industries or subdivisions of an industry, are grouped together in order to facilitate organization. Thus, in each of the important industries there are groups or syndicates, consisting of perhaps fifteen or possibly thirty shops. Each plant member of this group is an independent unit as far as its management is concerned, and it must stand on its own feet, notwithstanding the fact that it is under government control. The management of each plant is under a board of directors which passes upon all matters of importance. A managing director, or one whose position is comparable to that of works manager in this country, is selected on the basis of his special knowledge as related to the work of that particular plant. In addition to this active manager of the plant, there is always a government representative, who is the chairman of the board of directors and whose duty it is to see that the plant functions in accordance with government regulations.

Formerly the expert executives or managing directors received only a standard compensation, but it was found that failure to reward special ability and knowledge resulted in lack of incentive and, consequently, gross inefficiency. Under present conditions, many expert executives receive comparatively high salaries, unless they belong to the Communist Party, in which case the salary is limited to a standard amount. From this it might be inferred that the expert class among the executives would never be members of the Communist Party. Such, however, is not always the case, as a certain number are willing to make the monetary sacrifice.

The highest pay received by a party man is 192 rubles per month, no matter how expert he may be, whereas a non-party man, especially if he is a specialist in some particular line, may receive any amount from 250 rubles up. With this arrangement the government representative, who is, of course, always a member of the Communist Party, receives the standard salary of 192 rubles, whereas the managing director, assuming that he is not a Communist, may receive as much as 500 rubles per month. However, these specialists, in the various industries who receive extra compensation must prove themselves capable and efficient, and if one should "lie down on the job" (which was common prior to the introduction of this new system of payment), he will not only be discharged, but punished, if it is proved that he failed deliberately or with malicious intent. The shops and factories at the present time are clean and orderly, and the workers appear to be industrious and efficient. Rigid discipline is enforced, workers are not even being allowed to talk or smoke during working hours.

As regards imports of machinery, etc., the policy is to buy goods only when resources are available for meeting the payments. The question of credit is an important factor in the purchase of new equipment. While most manufacturers who are sending equipment into Russia desire cash payment, credits are being granted in certain cases. As far as the writer has been able to determine, all payments have been made promptly, and government banks will not endorse notes unless they are satisfied that such notes can be paid, as the government is anxious primarily to re-establish confidence in other countries.

Efforts are being made to obtain the most modern and efficient tools on the market. As far as machine tools are concerned, the trend seems to be more and more toward the use of American makes. While most of these imported machine tools are of the general utility type, quite a number of the more specialized designs are being installed, such as the automatic and single-purpose machines.

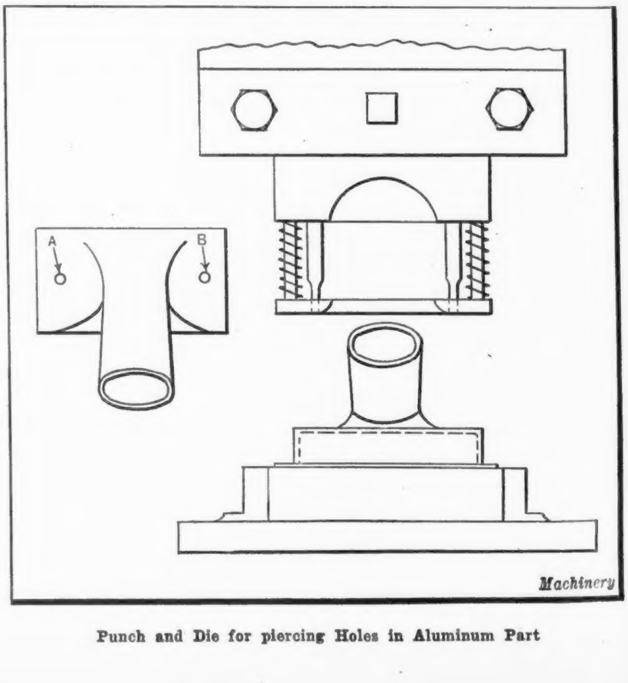
The general improvement in the various industries is reflected by the present condition of the railroad equipment. My first trip from Moscow to Leningrad (during my recent visit to Russia) required fourteen hours, and my last, just before leaving, required twelve hours. The railroad accommodations are far superior to any I have found in Europe. The dining car service and sleeping accommodations are excellent, and at no time during several trips to Leningrad and other centers, did the train leave behind the schedule. If the pronounced development of the last two years is any criterion as to future progress, Russia would appear to offer an important market for manufacturers of various classes of equipment, such as is required in the more important or basic industries.

* * *

PIERCING HOLES ON PUNCH PRESS

By E. O. KUENDIG

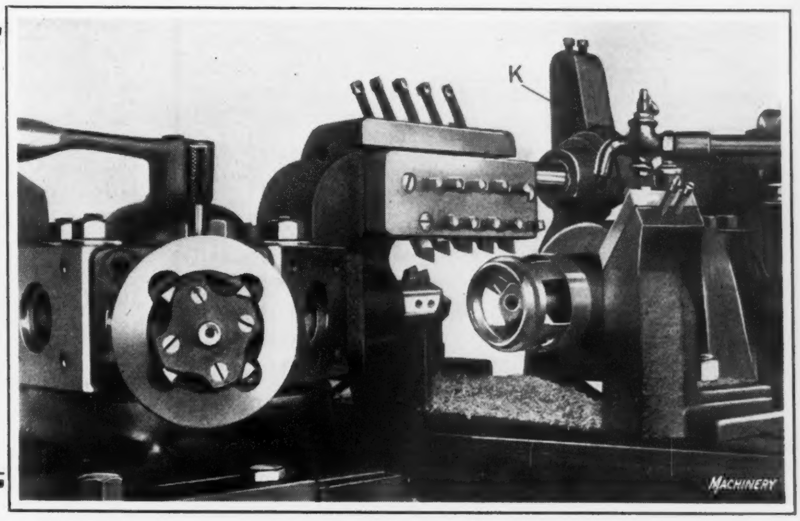
In the accompanying illustration is shown a punch and die used to pierce the holes *A* and *B* in a brush-nozzle attachment. The increase in production obtained by piercing instead of drilling these holes was over 100 per cent. The average production was 350 pieces per hour when the holes were drilled, and 800 pieces per hour when pierced on the punch press. The brush-nozzle is an aluminum casting, the thickness of the metal at the point where the holes are pierced being 7/64 inch. The diameter of the holes *A* and *B* is 0.1405 inch. It was found that practically no parts were spoiled when the holes were pierced on the punch press.



Punch and Die for piercing Holes in Aluminum Part

Screw Machine Tooling for Two-piece Pistons

By I. F. YEOMAN



ALUMINUM alloy pistons of a two-piece design in which the closed end consists of a separate cap screwed into the body, are being finished at a high production rate by employing an interesting set of tooling equipment in a Foster No. 5 screw machine. From Fig. 1 it will be seen that the outside of the piston body resembles a cone pulley and that one end is threaded internally to receive the head. This body is machined completely in the screw machine, with the exception of boring and facing the skirt end and drilling and reaming the holes for the piston-pin; these operations are performed before the body comes to the screw machine. The limits to which the screw machine is held on important dimensions range from plus 0.001 inch and minus 0.000 inch to plus or minus 0.003 inch. A close-up view of the tooling equipment is shown in the heading illustration, and Fig. 4 shows a diagrammatic layout of the tooling.

From Fig. 4 it will be seen that the work is supported by an adapter *A* on which a face *B* and surface *C* are ground to receive the face and bore of the skirt end of the body. These surfaces on the adapter are ground to the final dimensions after the adapter is mounted in place on the spindle nose of the machine so as to insure that they will be concentric with the spindle. Pin *D*, which is used to hold the piston body to the adapter, is ground to a neat sliding fit in the piston-pin holes. The pin also slides freely through draw-rod *E*, which is operated horizontally by means of the automatic chuck mechanism and hand-lever of the machine to clamp the piston body between ground face *B* of the adapter and pin *D*. As surface *C* fits the bored skirt closely, it centers the inside of the piston so that the wall thicknesses will be uniform when the outside surfaces are turned.

After the work has been seated on the adapter, the turret is advanced to feed four overhead turning tools *P* and two boring tools in bracket *J* across the work. The overhead tools are piloted by a bar that enters a hardened and ground bushing in bracket *K*. This bracket is similar in appearance to an ordinary lathe steadyrest, as may be seen from the heading illustration, and it is clamped to the ways of the bed in much the same way. The bushing may be adjusted into alignment with the pilot bar and locked in position by set-screws. In order to give additional rake or shear to the cutters, the holder is arranged to support them 1/2 inch in front of the spindle center. All cutters are clamped to the holder by two set-screws and adjusted through backing screws. At the same time that the rough-boring and rough-turning cuts are being taken by the tools in bracket *J*, the end of the piston body and the ring groove are faced by two tools in the multiple turning holder *F*, which is mounted on the front of the cross-slide.

Finish turning and boring cuts are then taken by the tools in bracket *H*, these tools being arranged the same as those in bracket *J*. However, in this finishing step the ring groove and front end of the piston are finish-faced by tools in the multiple holder *G* which is mounted on the rear of the cross-slide. The third and final step in the operation of machining the body consists of cutting the threads for the end cap. This step is performed with a Murchey collapsible tap which is located on the turret as shown at *I*.

A feature of this operation of machining the body is that while the body is of light construction throughout, and although seven tools are cutting simultaneously part of the time, the work is turned out well within the limits specified and free from distortion.

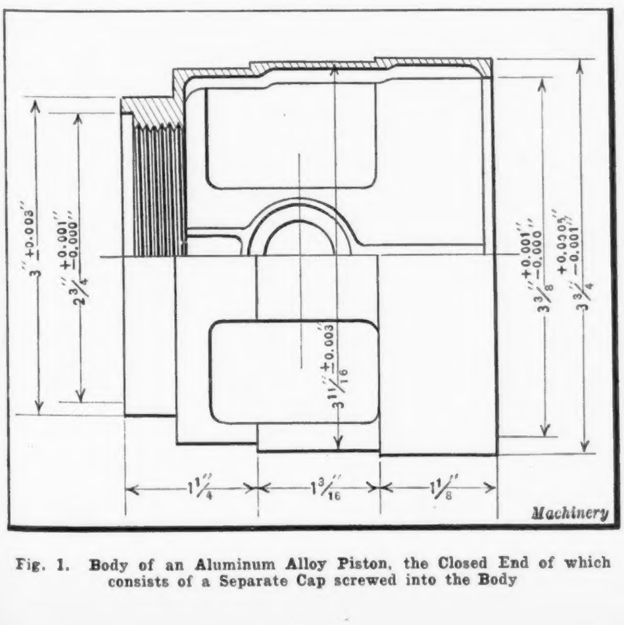


Fig. 1. Body of an Aluminum Alloy Piston, the Closed End of which consists of a Separate Cap screwed into the Body

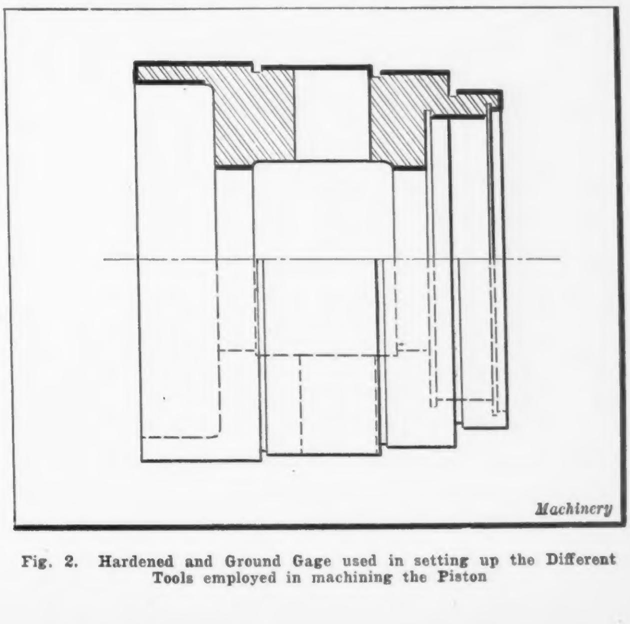


Fig. 2. Hardened and Ground Gage used in setting up the Different Tools employed in machining the Piston

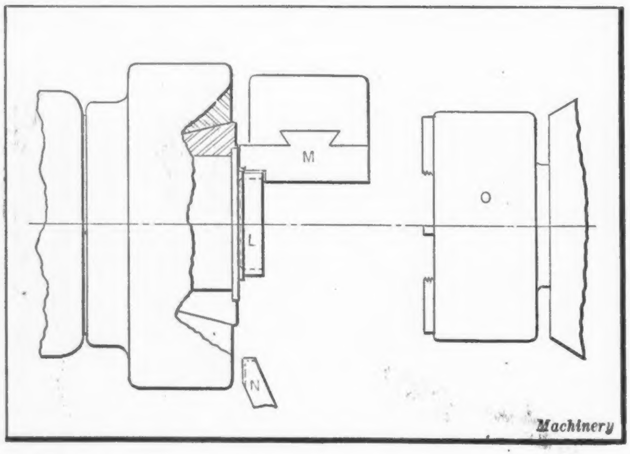


Fig. 3. First Chucking Operation performed on the Piston Head

In setting up the tools for this job, use is made of the gage shown in Fig. 2, which is made of steel, hardened and ground to suit the important dimensions of the piston body. This gage is mounted on the adapter in the same way as the piston, and the cutters are adjusted accordingly. By its use the setting up time has been greatly reduced, and the spoiling of the first two or three parts, which often occurs when tools are adjusted to work in the machine, has been eliminated.

Two operations are performed on the head which is later screwed into the piston body. Both operations are carried out in the same machine as the piston body, and to save setting-up time, the turning heads *H* and *J* are not removed from the turret. Fig. 3 shows the piston head at *L*, as held for the first operation. The form cutter *M* on the rear of the cross-slide turns all projecting surfaces and finish-faces the front side of the flange, this flange surface being first rough faced by the forged cutter *N* held in a toolpost on the front of the cross-slide. After the form cutter has been withdrawn from the work, the threading step is performed by means of a Geometric die-head *O* held on the turret.

After the first chucking, the head is screwed in the piston body and locked in place, after which the entire unit is mounted on the adapter in the same way as the piston body, as shown in Fig. 4. Then the end of the head that projects from the piston body is faced and turned to size, the first cutters *P* of the two turning heads being used for taking the turning cuts, while the facing is being done by forged cutters held in the front and rear toolposts of the cross-slide. Throughout these operations on both the head and body, the cuts are taken with the work rotating at a speed of about 500 feet per minute. The total time consumed in machining the two parts averages about two minutes.

* * *

Brazil has been an attractive market for German machinery in the last few years, although less German machine equipment is being sold there now than before the war. The fact that Brazil is one of Germany's best machinery markets is believed to be due to the large settlements of Germans in southern Brazil, who purchase machines of German manufacture whenever possible. In woodworking machinery, Brazil is Germany's best market, Argentina coming second. Other classes of machines that have had a fair market in Brazil are leather, shoe, and papermaking machinery, as well as textile machinery.

SPRING MEETING OF THE A. S. M. E.

A feature of the spring meeting of the American Society of Mechanical Engineers to be held in Milwaukee, Wis., May 18 to 21, will be a joint session with the American Society of Refrigerating Engineers. Papers of timely interest for the two groups will make up the program for the session. Milwaukee is a city of diversified industries, and excursions will be planned to a great many different types of manufacturing plants. It is also a city where industry and educational institutions have been working hand in hand in solving the problem of training workers, and an interesting method known as the District Apprenticeship Training Plan has been tried out in this city. Among the excursions of the meeting week, will be one to the plant of the Allis-Chalmers Mfg. Co.

The technical sessions will include papers on fuels, hydraulics, machine shop practice, oil and gas power, materials and material handling, steam power, management, railroading, and education and training for the industries. One session will be known as the Milwaukee Session, and will include papers dealing with features of the city of interest to mechanical engineers. One of the papers will deal with the economic advantages of a city having diversified industries.

* * *

The Society of Automotive Engineers, in reviewing its achievements for 1924, mentions that the membership of the society is now over 5400, new applications for membership during the past year numbering 760. More than one hundred national and section meetings were held during the year, at which were presented nearly 200 papers relating to problems in automotive engineering and production, and in the operation and maintenance of motor vehicles. About 125 of the papers presented at the meetings were printed in full in the Journal of the society. Eighty-five new and revised data sheets for the society's Handbook of Standards were issued. The employment service placed 145 members in positions during the year.

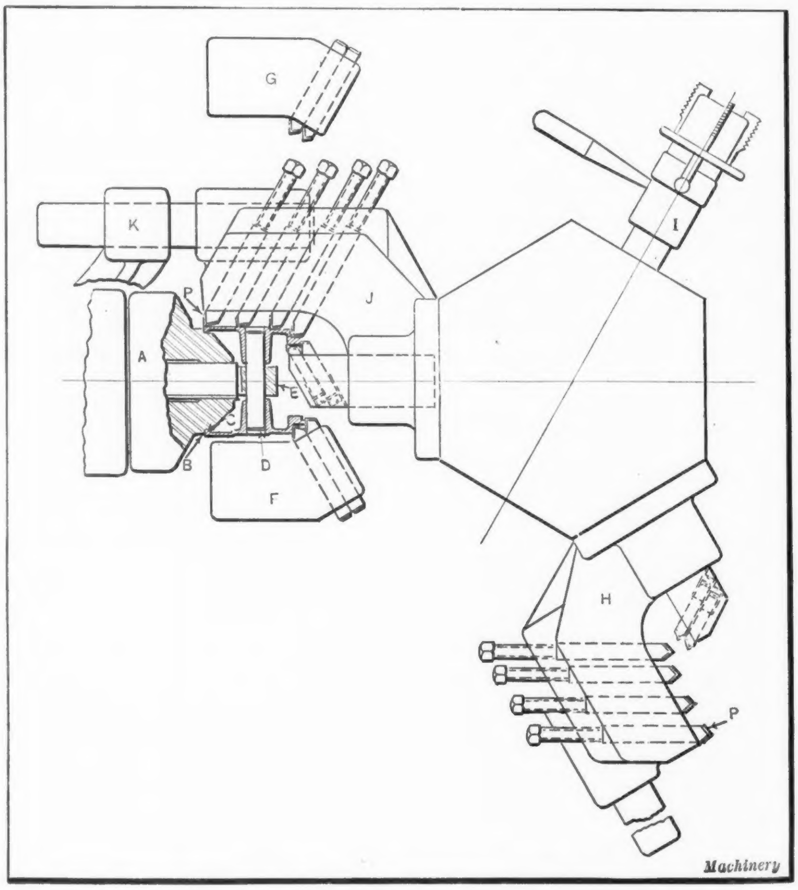


Fig. 4. Diagrammatic Lay-out of the Piston Body and Tooling

RELIEVING SPIRAL-FLUTED HOBS

By G. D. HUTCHINGS

In relieving spiral-fluted hobs of more than one thread, it is necessary either to advance or retard the relieving attachment when indexing the hob from one thread to another, in order to maintain the same relation between the relieving tool and all hob teeth. This correction may be conveniently made by disconnecting the gearing between the work and the relieving attachment, advancing or turning back the gears of the attachment the required amount, and then reconnecting the gears. It is, of course, necessary to determine how many teeth the first gear in the train of the relieving attachment must be advanced or turned back.

It is first required to calculate the change-gears for the relieving attachment. These gears must have a ratio equal to $\dfrac{N}{C\,(\cos^2 a)}$, in which

N = number of spiral flutes in hob;

a = helix angle of threads from a plane perpendicular to axis of hob;

C = a constant of the relieving attachment.

The constant C can be determined from the index-plate of the relieving attachment. It equals the number of straight flutes that require equal gears on the change-gear studs. This constant varies with different makes of lathes.

For the purpose of illustrating the method to be described, assume that it is required to relieve a hob having eleven spiral flutes, six threads, and a helix angle of 12 degrees 49 minutes 30 seconds. Also assume that a relieving attachment having a constant of 4 is to be used. In calculating the change-gears, it is desirable to select such a number of teeth for the stud gear that this gear will revolve an even number of teeth in relieving one tooth of the hob. Hence it is necessary to determine the number of teeth along a thread in one revolution of the hob, this length of thread being represented in the diagram by line AC. The stud gear makes one revolution for each revolution of the hob.

Let T equal the number of teeth along a thread for one revolution of the hob, then

$$T = \frac{N}{\cos^2 a} = \frac{11}{(0.97505)^2} = \frac{11}{0.950722} = 11.5, \text{ approximately}$$

Now calculating the change-gears,

$$\frac{N}{C\,(\cos^2 a)} = \frac{11}{4\,(\cos.\ 12\text{ deg. } 49\text{ min. } 30\text{ sec.})^2} =$$

$$\frac{11}{4\,(0.97505)^2} = \frac{11}{4\,(0.950722)} = \frac{69 \times 54}{46 \times 28} = \frac{\text{driving gears}}{\text{driven gears}}$$

(This calculation may be greatly simplified by using the table "Logarithms of Gear Ratios" which is published in the sixth edition of MACHINERY'S HANDBOOK.) As the stud gear has 69 teeth the number of teeth that this gear revolves in relieving one hob tooth equals 69 ÷ 11.5 or 6 teeth.

Now referring to the diagram,

AB = circumference of hob along pitch diameter;

BC = lead of hob; and

AC = developed length of a thread in one revolution of hob.

The starting points of the six threads are represented by the lines rising from the Roman numerals I, II, III, etc., and the eleven flutes are shown at right angles to the six threads by lines 1, 2, 3, etc.

It can be readily seen that when indexing the hob for relieving the second thread which begins at I, the relieving tool must either be advanced a certain distance represented by a_1 or retarded a distance represented by a in order to bring the relieving tool into the proper position relative to either flute 2 or 3. Now

$$a = \frac{2}{11} - \frac{1}{6} = \frac{1}{66} \text{ of } AB$$

$$a_1 = \frac{1}{6} - \frac{1}{11} = \frac{5}{66} \text{ of } AB$$

Therefore, $a = \dfrac{1}{6}\,(a + a_1)$ and $a_1 = \dfrac{5}{6}\,(a + a_1)$

Let $a + a_1$ = number of teeth of stud gear required in relieving one tooth of hob, already found to be 6. Then

$$a_1 = \frac{5}{6}\,(a + a_1) = 5 \text{ teeth}$$

$$a = \frac{1}{6}\,(a + a_1) = 1 \text{ tooth}$$

Likewise,

$$b = \frac{4}{11} - \frac{2}{6} = \frac{2}{66} = 2 \text{ teeth}$$

$$c = \frac{6}{11} - \frac{3}{6} = \frac{3}{66} = 3 \text{ teeth}$$

$$d = \frac{8}{11} - \frac{4}{6} = \frac{4}{66} = 4 \text{ teeth}$$

$$e = \frac{10}{11} - \frac{5}{6} = \frac{5}{66} = 5 \text{ teeth}$$

From these calculations it will be seen that it is necessary to retard the change-gears of the relieving attachment one tooth of the stud gear each time that the hob is indexed one thread, and so if the hob were indexed three threads it would be necessary to retard the change-gears three teeth and so on. This correction can be conveniently made by disengaging the stud gear, swinging the radius bar sufficiently so that the stud gear will clear the intermediate gear, retarding the intermediate gear one tooth in relation to the stud gear, and finally re-engaging the stud and intermediate gears. The relieving operation can then proceed.

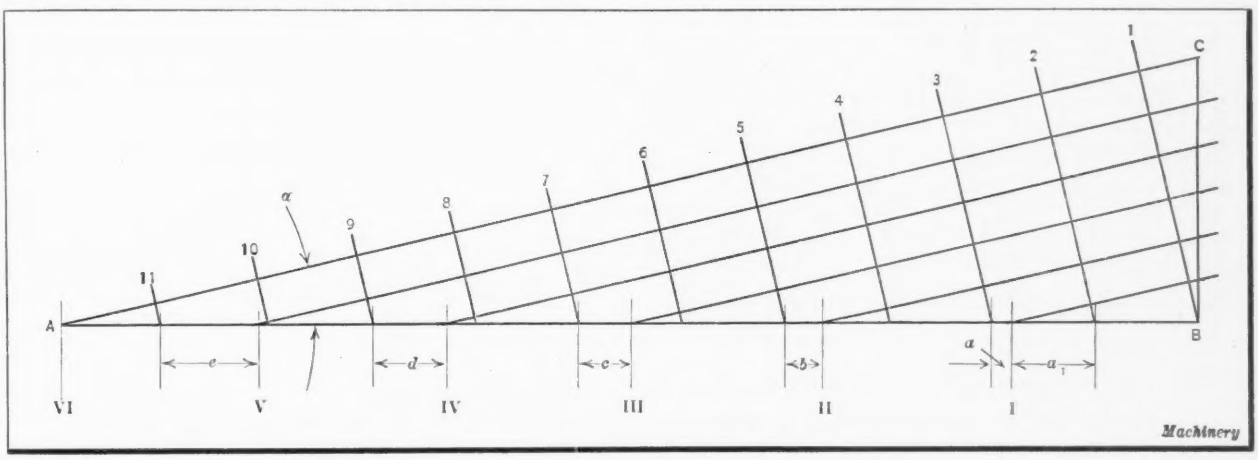


Diagram illustrating Points that arise in relieving Spiral-fluted Hobs

BROACHING WRENCH SLOTS ON FRICTION POWER PRESS

H. C. TEN HORN

The special friction power press tool equipment shown in the accompanying illustrations was designed for use in broaching the slots in wrenches of the type shown at *F*, Fig. 1. The press on which this equipment is used is capable of exerting a pressure of 120 tons. This pressure is sufficient to permit broaching several wrenches at a time, but as the broach-bar can act through a distance not greater than 14 inches, the best results are obtained by broaching only three wrenches at a time. If an attempt is made to handle more pieces in one operation, the broach will not cut so clean a slot.

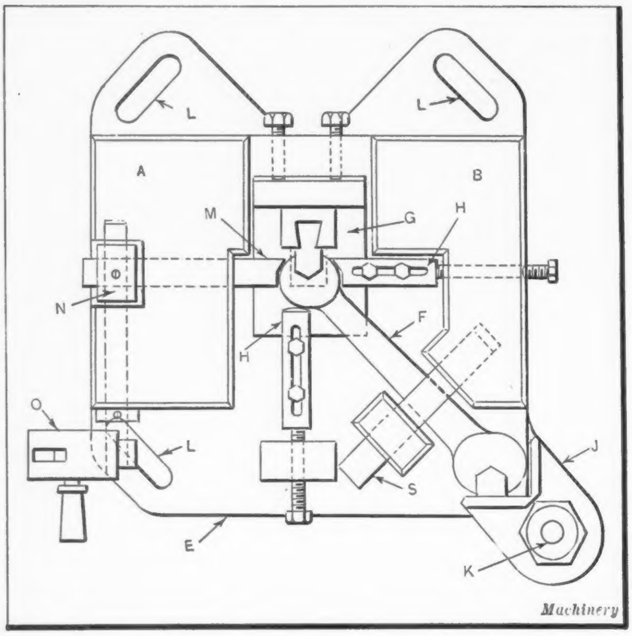


Fig. 1. Plan View of Fixture used in broaching Wrench Slots

The first step in designing the broaching fixture was to provide some means of positively preventing the ram from descending far enough to cause the screw axle to bind. This was accomplished by having blocks *A* and *B* cast on the bed *E* and securing a plate *C*, Fig. 2, to the broach-holder *D*. The plate *C*, coming in contact with blocks *A* and *B*, will prevent the ram from descending far enough to injure any part of the equipment or cause the friction-driven screw to bind.

The wrenches *F*, Fig. 1, are supported on the bushing *G* at one end, and on the table at the opposite end. The locating pieces *H* are so adjusted that they center the end to be broached in the fixture. The outer ends of the wrenches are held in position by the V-block *J* which is secured to the body of the fixture by the bolt *K*. This bolt also secures the fixture to the frame of the press. Clamping bolts extending through holes *L* hold the fixture firmly in place. A sliding steel rod *M* actuated by an eccentric or lever *N* which is provided with a weight *O*, exerts a clamping pressure on the wrenches. When the handle *P*, Fig. 2, is moved to the right, the rod *M* slides out of contact with the work. A rod *S*, which passes through a hole in block *R* into a recess in block *B*, holds the wrenches down in contact with the bed of the fixture.

When the fixture is in use, three wrenches are placed in contact with the locating pieces *H* and *J*, Fig. 1, after which the rod *S* is slid into position. The handle *P*, Fig. 2, is then swung to the left thus completing the clamping of the wrenches in the fixture. Slots of different widths may be cut by changing the broaches. It will be noted that instead of being drawn through the work in the usual manner, the broach is pressed or forced through the parts to be machined. The broach must, therefore, withstand a high pressure, and for this reason is clamped in a holder *U*. The under part of the broach is not provided with teeth, and is made small enough to permit the wrenches to be brought into position while the end of the broach is in the opening in the bed of the work-holding fixture.

At the end of the working stroke the plate *C* comes in contact with the blocks *A* and *B*. While the operator holds the ram down with his left hand, he swings handle *P* to the right with his right hand and removes the pin *S*. The wrenches are removed while the ram remains down, in order to prevent dulling the cutting edges of the broach. After the wrenches have been removed, the ram is moved up by an upward movement of the control handle of the press. After a little experience, the operator had no difficulty in broaching 296 wrenches per hour.

* * *

NEW A. S. M. E. POWER TEST CODE FOR STATIONARY STEAM BOILERS

In 1886 a committee appointed by the American Society of Mechanical Engineers formulated a code for testing steam boilers which soon became the standard practice of the profession and the basis upon which performance guarantees were drawn and settled. At that time there were no other recognized rules for practice extant in this country. In the thirty-eight years that have elapsed since the adoption of the original A.S.M.E. code it has undergone several revisions made necessary by the progress of the field. Such a revision has just been completed and the code is now available in the thoroughly up-to-date form in which it has been adopted by the Council of the American Society of Mechanical Engineers as the approved standard practice of the profession.

* * *

A comparison of the percentage of increase in the use of automobiles in the United States and foreign countries in the last ten years is of considerable interest. In this country there are today ten times as many automobiles in use as there were ten years ago. In Spain, there are six times as many as ten years ago; in Belgium, Italy, Holland, and Denmark, about five times as many; in France, four times as many; in Germany, three times as many; and in Great Britain, about two and one-half times the number in 1914.

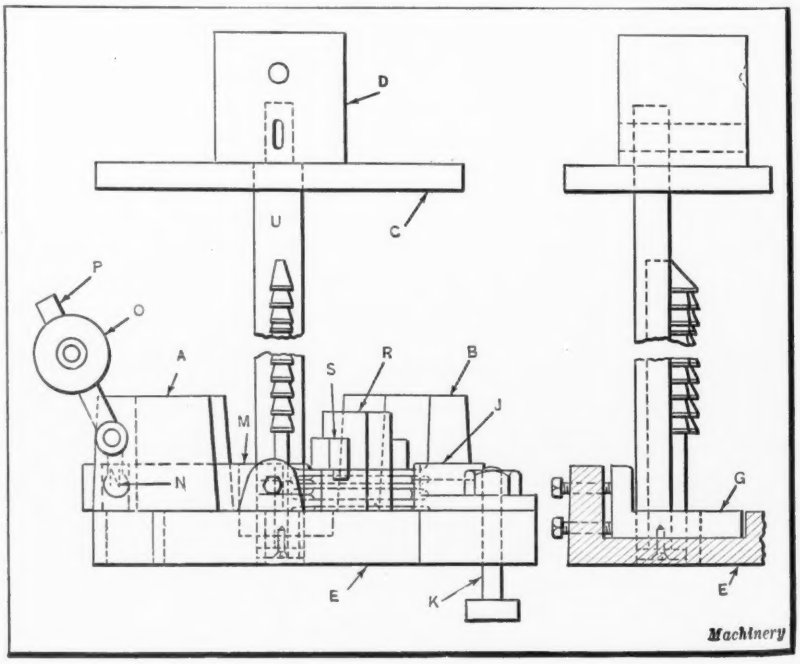


Fig. 2. Elevation Views of Fixture shown in Fig. 1

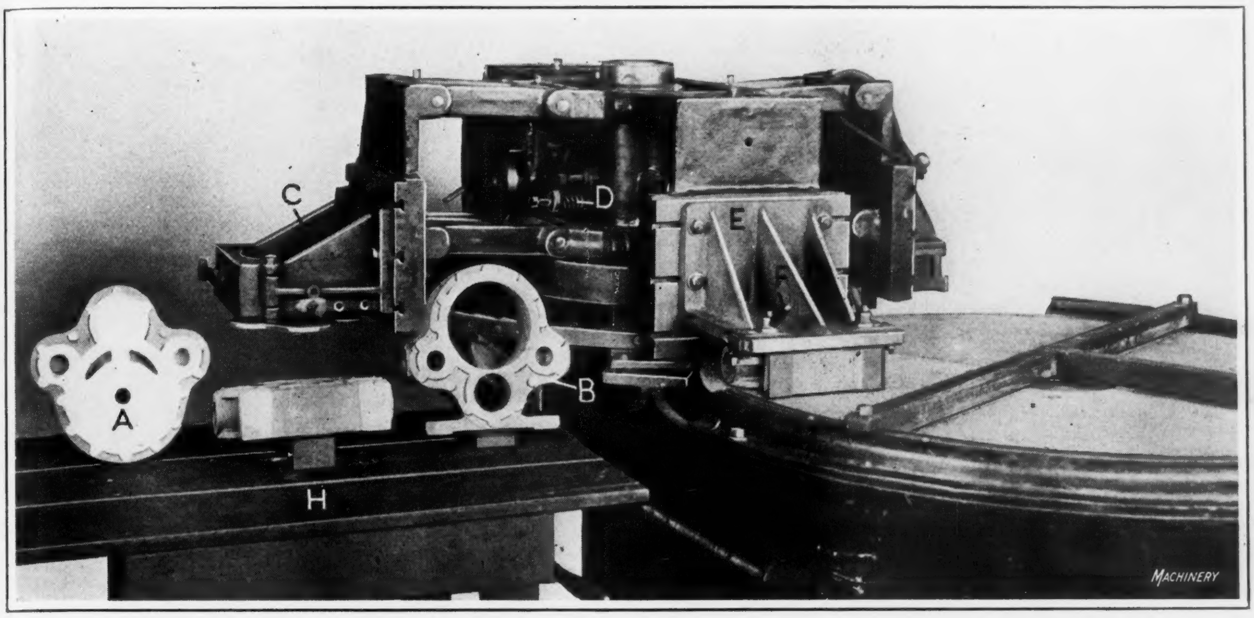


Fig. 1. Continuous-feed Disk Grinder equipped for grinding Liquid-air Pump Castings

Automatic Disk Grinding

Typical Operations Performed on Disk Grinding Machines of Recent Development

THE rapid increase in the use of disk grinders within the last few years has been accompanied by a marked improvement in machines of this kind and their equipment. Among the most recent developments are the continuous-feed type of grinder such as is used in grinding the liquid-air pump castings shown at *A* and *B*, Fig. 1, the semi-automatic type used in finishing the ends of the radiator nipples shown in Fig. 4, and the Oilgear feed double-spindle type employed in the manner indicated in Fig. 8 for simultaneously squaring both ends of such work as springs and bushings. These three types of machines, as made by the Gardner Machine Co., Beloit, Wis., are used in performing the various disk grinding operations described in this article.

Grinding Liquid-air Pump Castings

The cast-iron pieces shown at *A* and *B* in Fig. 1 are the cover and body, respectively, of a liquid-air pump. The cover is required to be ground perfectly flat on one side, and the body must be ground flat on both sides and on the feet. In grinding the covers, each of the four work-holding tables of the revolving reel is provided with a fixture like the one shown at *C*, Figs. 1 and 2. Although fixtures for different parts are shown on the work-tables in the illustrations the tables are all provided with the same fixtures when the machine is in use.

The covers *A* are clamped in the fixtures by means of set-screws, one of which is shown at *S*, Fig. 2. The loading and unloading of the fixtures is accomplished as the continuously rotating reel passes the loading table shown at *H*, Fig. 1. The tables carrying the work-holding fixtures are automatically lowered to bring the work into contact with the grinding disk as they pass across its surface. The weight of the table serves to press the work against the grinding disk, the correct grinding pressure being obtained by adjusting the compression spring *D* to give the required counterbalancing effect.

The work-carrying reel can be operated at a speed of 1/4, 1/2, or 1 revolution per minute, thus producing one, two, or four finished pieces per minute. The regular production on the covers, involving the removal of from 1/32 to 1/16 inch of metal on a surface about 10 inches in diameter, is 24 finished pieces per hour. This includes the roughing cut, taken with the work held in the fixtures on the reel, and the hand-finishing operation in which the workman holds the cover lightly on the wheel, as indicated at the right in Fig. 2.

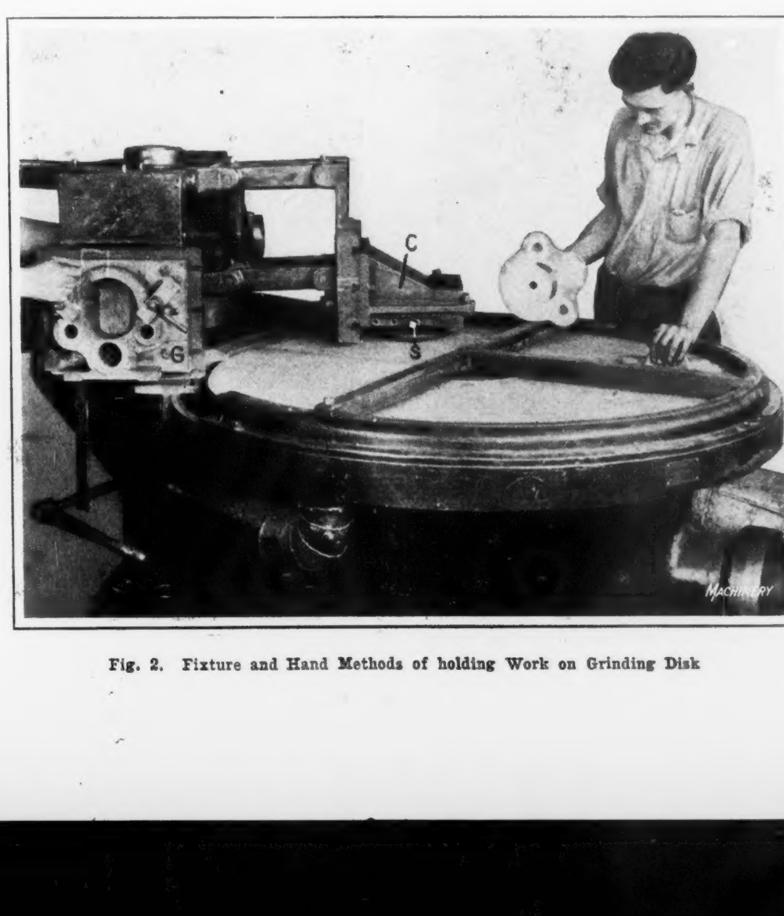


Fig. 2. Fixture and Hand Methods of holding Work on Grinding Disk

At *E*, Fig. 1, is shown one of the fixtures for holding the body *B* when grinding one side. Two nuts *F* are used to clamp the work in place. In this case, the work is held in the fixture for rough-grinding and is finished with light hand cuts. The production, including rough-grinding and hand finish-grinding on both sides, is 15 pieces per hour. After the sides of the work have been finished, the feet are ground by clamping the pieces in fixtures such as shown at *G*, Fig. 2, the produc-

tion rate for this operation being 200 pieces per hour. The wheel used for all grinding operations on the liquid-air pump cover and body is a No. 166 deep-corrugated Gardner G.I.A. disk.

Grinding Segmental Truck Wheels

In Fig. 3 is shown a segment *A* of a truck wheel mounted on a special indexing fixture of a disk grinding machine of the type used in grinding the liquid-air pump castings. The wheel segments are malleable iron and must be ground on both sides. After one side has been ground, the workman, by a simple indexing movement, turns the piece around so that the other side will come in contact with the grinding wheel as the work is carried around by the revolving reel. The area ground on each side is about 7 square inches, and the depth of the cut about 1/16 inch. The production on this job is 40 segments per hour, with a No. 125 Gardner G.I.A. grinding disk.

Fig. 3. Grinding Segmental Truck Wheel Castings

Finishing Radiator Nipples

The cast-iron radiator nipples, one of which is shown at *A*, Fig. 4, are required to have from 1/16 to 3/32 inch ground from one end. This operation is performed on the semi-automatic disk type of grinder shown in Figs. 4 and 5. The work-holding and feeding arrangement on this machine is so designed that all the operator has to do is to place the work in the feed-chute *B*. From this chute the work falls into notches in the feeding wheel which carries it across the grinding disk. After passing across the grinding disk, the pieces drop into a chute *C*, Fig. 5. The spring-actuated plates *D* of the feeding wheel serve to press the work against the disk wheel for the grinding cut. As these plates approach the loading position, they are forced back by the cam-bar *E*, to permit the pieces to drop into the notches. When the plates *D* reach a position over the grinding wheel, they slide off the cam *E* so that the springs *F* are allowed to press the work against the grinding disk. The wire cable *G* running over the two pulleys *H* and *I* holds the work in the notches of the feeding wheel while it is in contact with the grinding disk. The production on these parts is 64 per minute, with a No. 126 Gardner G.I.A. disk.

Grinding Automobile Circuit-breaker Bases

The machine shown in Figs. 6 and 7 is like the one shown in Figs. 4 and 5, but it is provided with a work-carrying drum equipped with fixtures for holding automobile circuit-breaker bases. The work drum has eight faces and carries a fixture on each face. The steel circuit-breaker bases are held in the fixtures by springs, the operator simply pressing the work into place and releasing it by means of a spring plunger *A*, Fig. 7, after it has passed over the grinding wheel. The area of the surface ground on these parts is about 1 square inch, and the depth of the cut 0.025 inch. The production is about 21 per minute, although this rate depends on the ability of the operator. The disk used for this work is a No. 167 Gardner G.I.A.

Squaring Ends of Coil Springs on Double-spindle Disk Grinders

In Figs. 8 and 9 is shown a double-spindle Oilgear feed type of disk grinder. On this machine, the work is located in a holder which is placed between the grinding disks, after which the oilgear feed advances the spindles, bringing the grinding disk into contact with both ends or sides of the work simultaneously. The arm on which the work-holder is mounted is automatically oscillated by a cam arrangement during the grinding operation. Referring to the enlarged view, Fig. 9, it will be noted that twenty springs are located

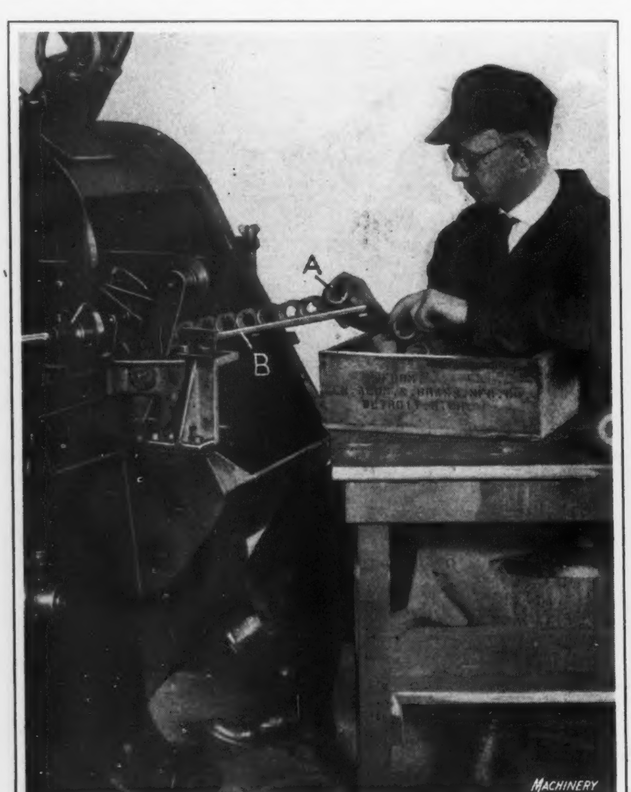


Fig. 4. Grinding Radiator Nipples on Semi-automatic Disk Grinder

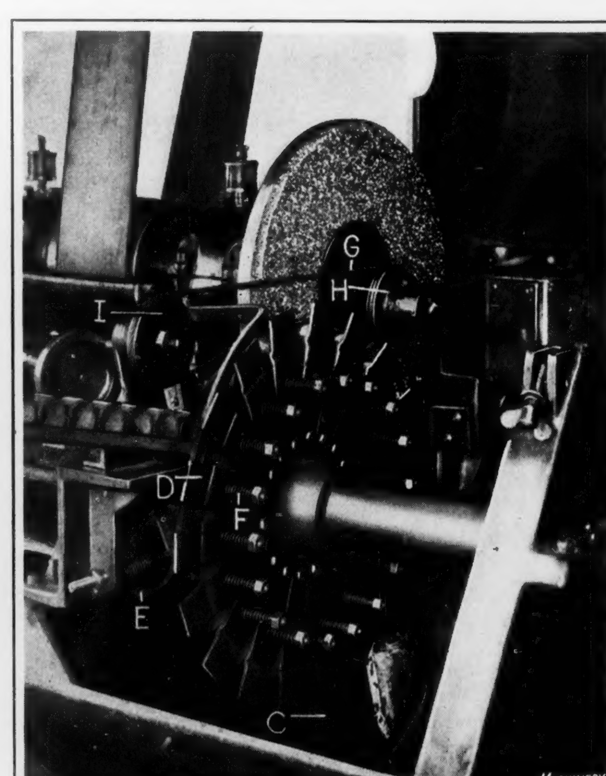


Fig. 5. Work-holding and Feeding Mechanism of Machine in Fig. 4

Fig. 6. Machine equipped for grinding Circuit-breaker Bases

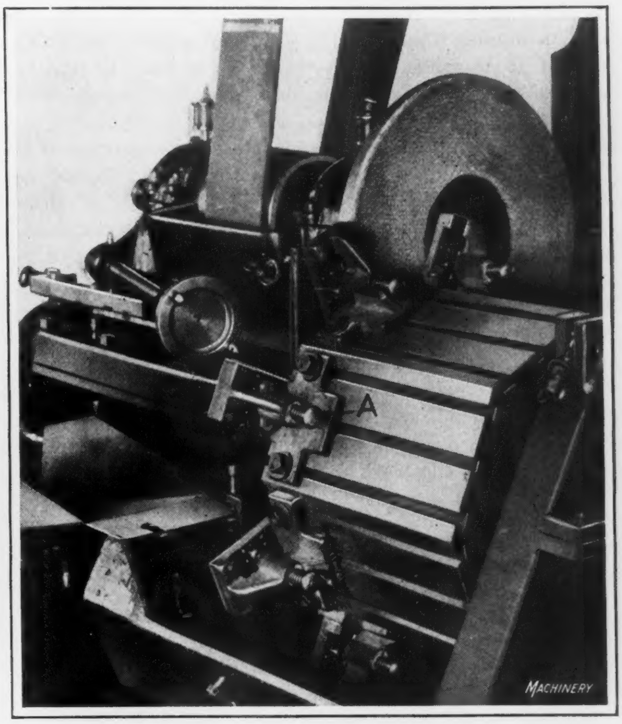


Fig. 7. Fixture-holding Drum of Machine shown in Fig. 6

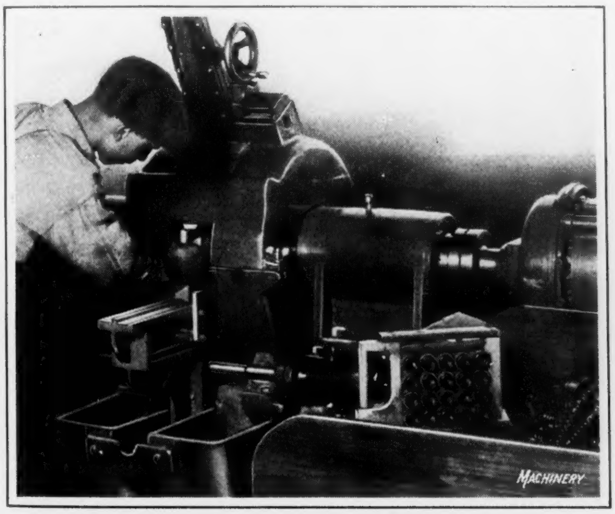


Fig. 8. Squaring Ends of Coil Springs on Oilgear Feed Double-spindle Disk Grinder

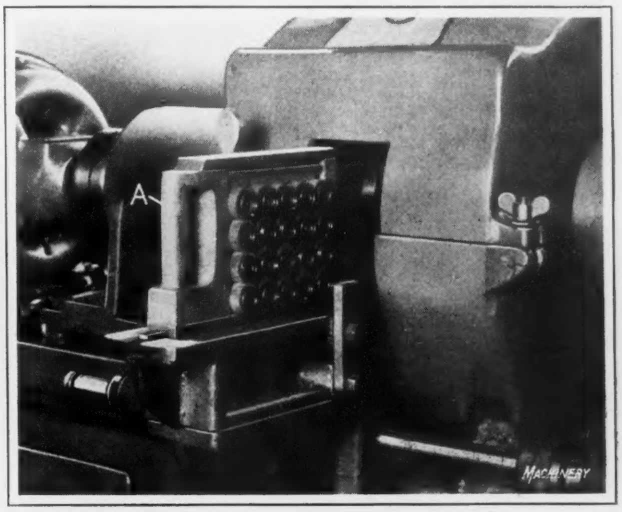


Fig. 9. Enlarged View of Work-holding Fixture used on Machine illustrated in Fig. 8

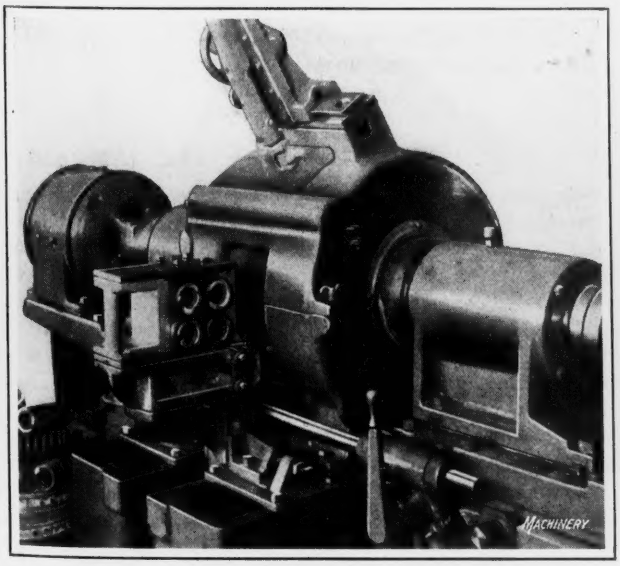


Fig. 10. Fixture employed for grinding Ends of Heavy Coil Springs

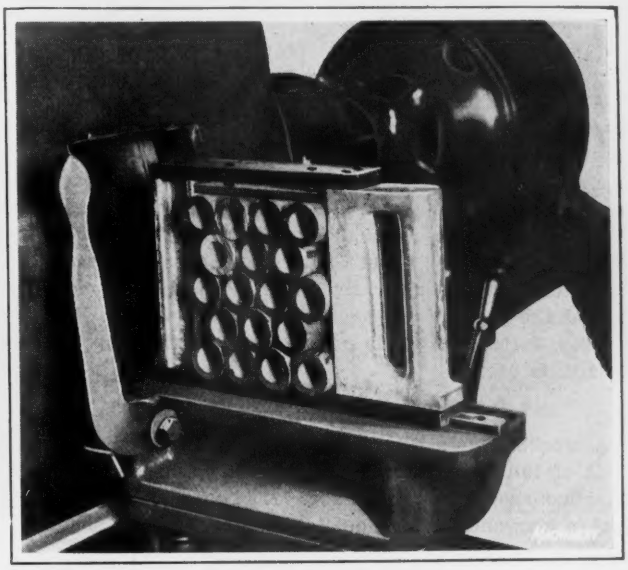


Fig. 11. Bronze Bushings loaded in Fixture for End-grinding Operation

in the holder A. Each of these springs is 3½ inches long, has an outside diameter of 1⅛ inches, and an inside diameter of 13/16 inch. The short pieces of tube in which the springs are placed keep the work properly aligned, and at right angles with the faces of the grinding disks, but at the same time permit the work to have a certain amount of float.

Two work-holders are employed, one being loaded while the other is locked in the machine. When the machine is in operation, the workman pushes the holder into place between the disks in the manner shown in Fig. 8, and locks the fixture in place by swinging over a latch like the one shown at A, Fig. 13. The grinding disks are then brought into contact with the work until a temporary stop is reached, after which the oilgear feed advances the spindles at an even pressure, which is particularly adapted to spring grinding requirements, until a properly adjusted positive stop is reached. The operator then notes the nature or number of sparks leaving the work and wheel, and in this way determines just when to remove the work. The production on this job with a No. 367 Gardner G.I.A. disk is 500 pieces per hour. In this particular case, the work is required to be very accurate. When the springs have a greater tolerance, a production rate of 900 pieces per hour is obtained.

Another spring-grinding operation similar to the one just described but performed on coil springs of a heavier design is illustrated in Fig. 10. The coil springs, four of which are mounted in a holder at a time, are 5¾ inches long, with an outside diameter of 2¼ inches and a wire diameter of 13/32 inch. The seats of these springs must be flat, requiring the removal of about 5/16 inch of metal on each end. In spite of the comparatively large amount of metal removed, the production rate is 200 springs per hour. For this work a Norton No. 30 J alundum ring wheel, 18 by 7 inches in size is used.

Squaring Ends of Bronze Bushings

A work-holder similar to that employed in squaring the ends of coil springs is used in grinding the ends of bronze bushings such as shown in Fig. 11. These bushings are 2⅝ inches long and have an outside diameter of 1⅜ inches and a hole through the center ⅞ inch in diameter. Eighteen bushings are placed in a holder at a time, and two holders are provided, one being loaded while the other is held on the machine. The total amount of stock removed from both ends of the bushings is 1/16 inch, and the work is required to be held within plus or minus 0.005 inch of the specified length. A No. 243 Gardner G.I.A. disk is used for the grinding operation on the bronze bushings. The production obtained is 1600 bushings per hour.

Grinding Carbon Brushes

In Fig. 12 is shown a double-spindle Oilgear feed disk grinder equipped for grinding carbon brushes. Four carbon brushes, one of which is shown at B, are placed in a holder having openings slightly larger than the brushes. The brushes are ⅝ inch thick, 1¾ inches wide, and 2½ inches long, and are required to be ground square on all sides with a tolerance of plus or minus 0.002 inch. About 1/32 inch of stock is removed from each surface. When grinding the ends and edges, ten brushes are placed in the holders at a time. The holders are changed every twelve or fifteen seconds, and the production obtained is from 600 to 700 complete pieces per hour. For this grinding operation, a No. 369 Gardner G.I.A. disk is employed. Fig. 13 shows the machine with one of the work-holding fixtures locked in place on the oscillating member C.

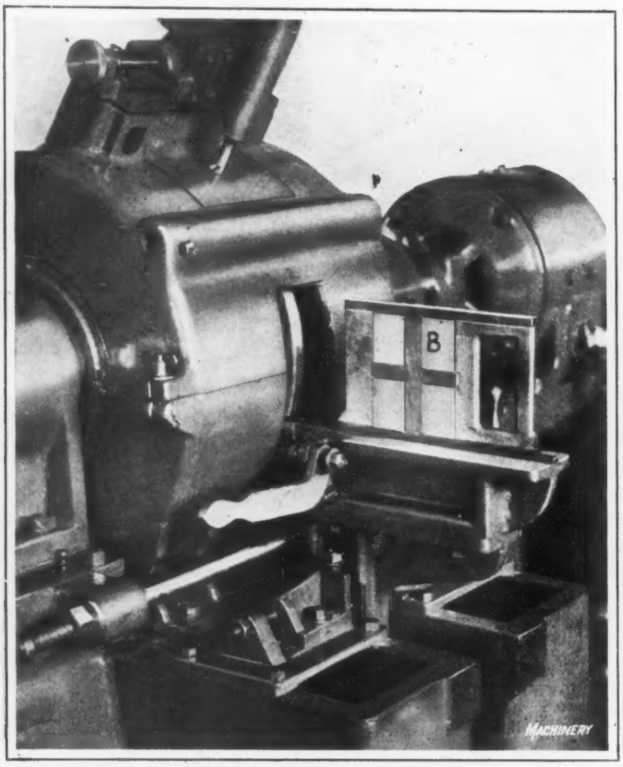


Fig. 12. Equipment used in grinding Carbon Brushes

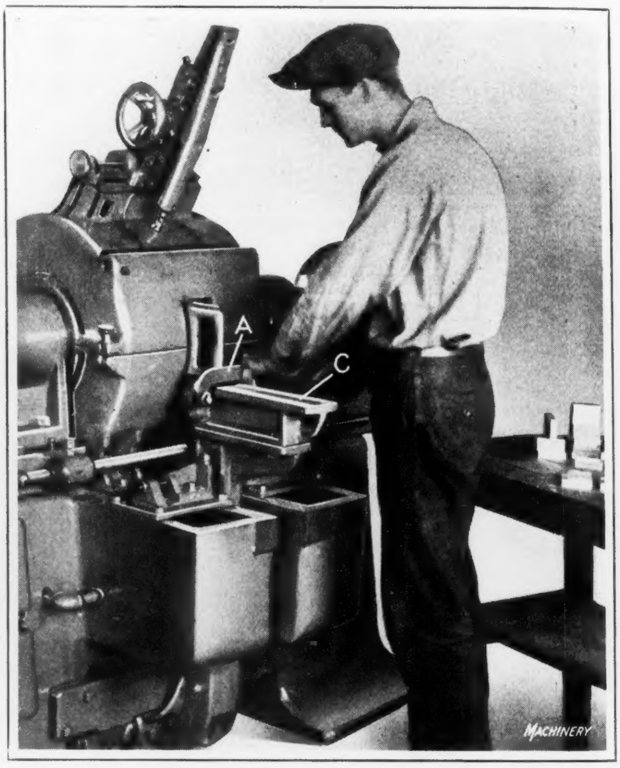


Fig. 13. Machine with Work-holder in Grinding Position

* * *

ACCIDENTS REDUCED BY SAFETY CAMPAIGN

Some interesting figures have been collected by Henry Disston & Sons, Inc., saw manufacturers of Philadelphia, Pa., to show how accidents can be reduced by an active safety campaign in the plant. At the annual safety meeting in the plant of this company, A. N. Blum, chief engineer and chairman of the general safety committee, mentioned that in 1916 with a smaller working force than at present, there were 5471 working days lost in the plant as the result of about 300 men being injured due to accidents. In 1924, after nine years of efforts to provide safe working conditions, only 71 men suffered from accidents causing loss of one or more days' time, and only 1174 working days were lost through accidents. These figures are particularly impressive when expressed in percentages. They show that since 1916 a reduction of about 80 per cent has been made in the number of accidents, and 78 per cent in the number of lost days.

Gang Fixtures for Quantity Production

By F. L. LIBGOTTE

THE fixtures illustrated and described in this article are used in machining the part shown on an enlarged scale in Fig. 1. Two sets of cages or bases for holding the work are provided for each fixture so that one set can be loaded while the other holds the work that is being machined. The idle machine time is very low when fixtures of the design shown are employed. In some cases it is possible for workmen to operate several machines, so that the idle time of the operator is also reduced to a minimum. In other cases the operator performs hand operations on the work—such as removing burrs—between the loading operations.

The production rate on this part is 5000 finished pieces per day. It is made from half-hard drawn steel of the cross-sectional shape indicated at *A*, Fig. 2. The dimensions shown in Fig. 1 are intended to give the reader an idea of the size of the work, which is machined all over, and which is required to be accurate within very close limits. The hook *B* is formed by bending the end of the part after some of the machining operations have been performed. It was found quicker and simpler to cut the stock into pieces long enough for two parts, and machine these pieces to the shape indicated at *C*, Fig. 2, before cutting the pieces apart on the line *a*. Two circular saws are used in cutting up the stock, which is held in a vise in lots of four bars.

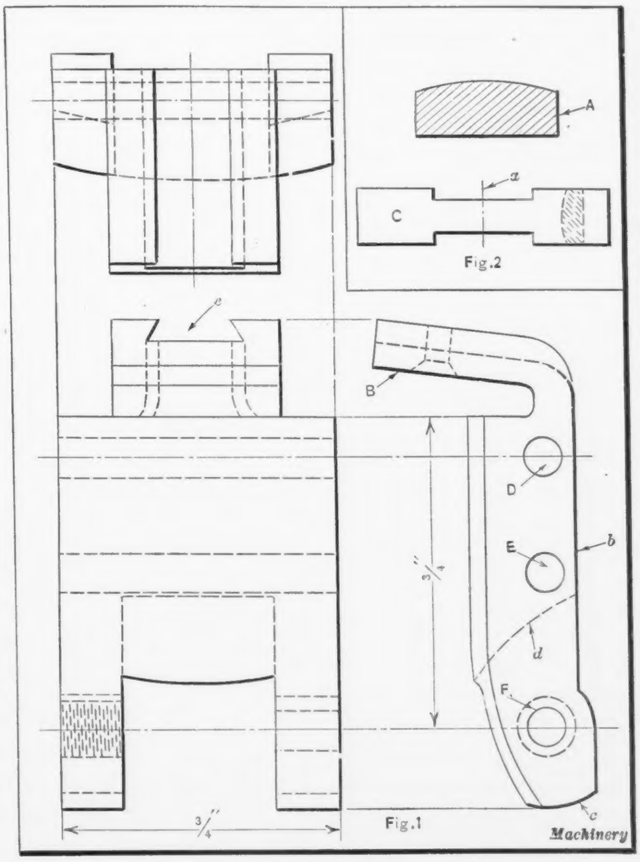


Fig. 1. Piece machined from Half-hard Drawn Steel. Fig. 2. (A) Cross-section of Drawn Steel Stock from which Part shown in Fig. 1 is made; (C) Partly Machined Piece as it appears before being cut off at (a) to form Two Parts

In the second operation, the ends of the pieces cut from the bar stock are milled so that all the pieces will be of the same length. An ordinary machine vise provided with a cage *D*, Fig. 3, in which twenty or more of the pieces are held, is employed for this milling operation. The cage *D* is also shown in Fig. 5. The work is clamped in the cage by tightening the screw *E*, Fig. 3. The cage *D* is so located that the vise jaws *F* and *G* bear directly on the work, an allowance being made for the free housing of the cage. Two cages are provided so that the operator can fill one while the other holds the pieces being machined. The jaws *F* and *G* of the vise are made of mild steel and are casehardened, while the cage *D* is made of half-hard steel.

Fixture with Eccentrically Operated Clamps

In the third and fourth operations, the sides of the pieces are milled away at the center so that they have the shape indicated by the view at *C*, Fig. 2. The fixture used for these operations is shown in Fig. 4. Two cuts are taken simultaneously by the cutters *A* and *B*, the pieces being held in the two cages *C*. The grooves at *a* extend the full length of the cages, an opening *d*, as shown in the view in the upper right-hand corner of the illustration, being provided at one end to permit the work to be placed in the grooves. The pieces are clamped in place in the cage by tightening screw *E*.

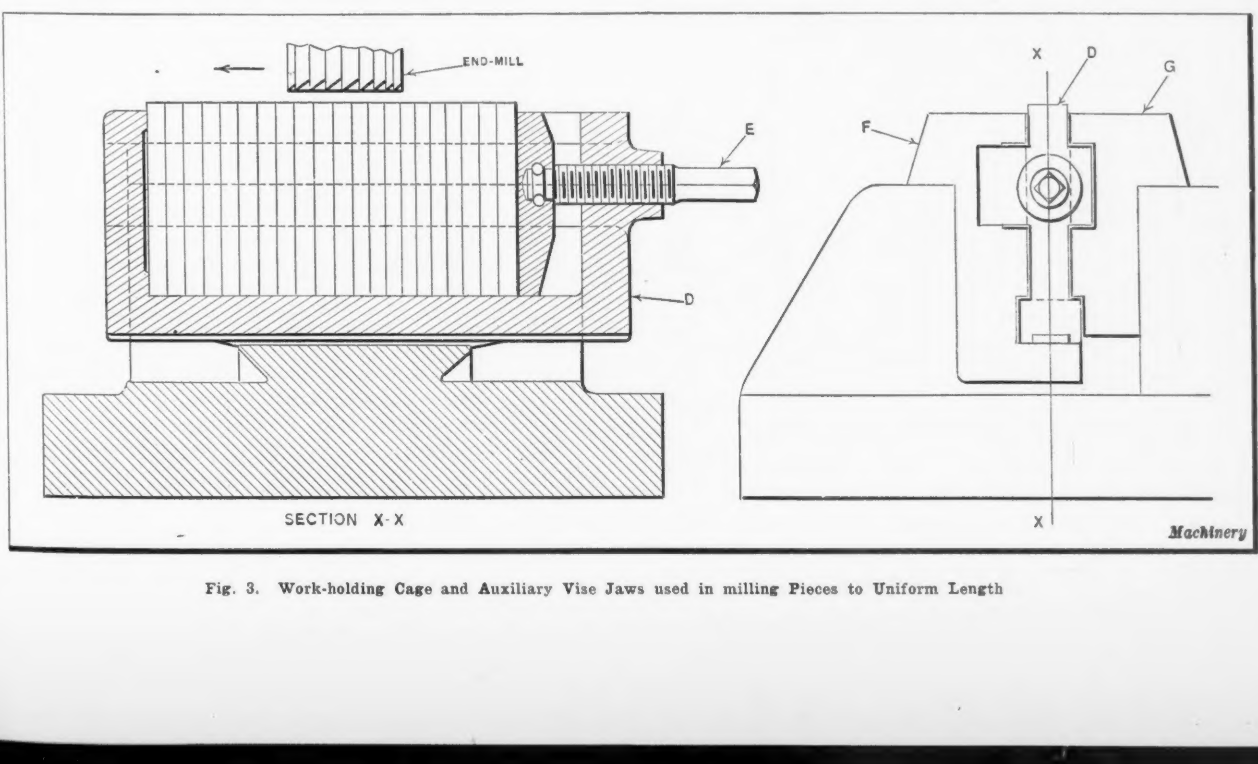


Fig. 3. Work-holding Cage and Auxiliary Vise Jaws used in milling Pieces to Uniform Length

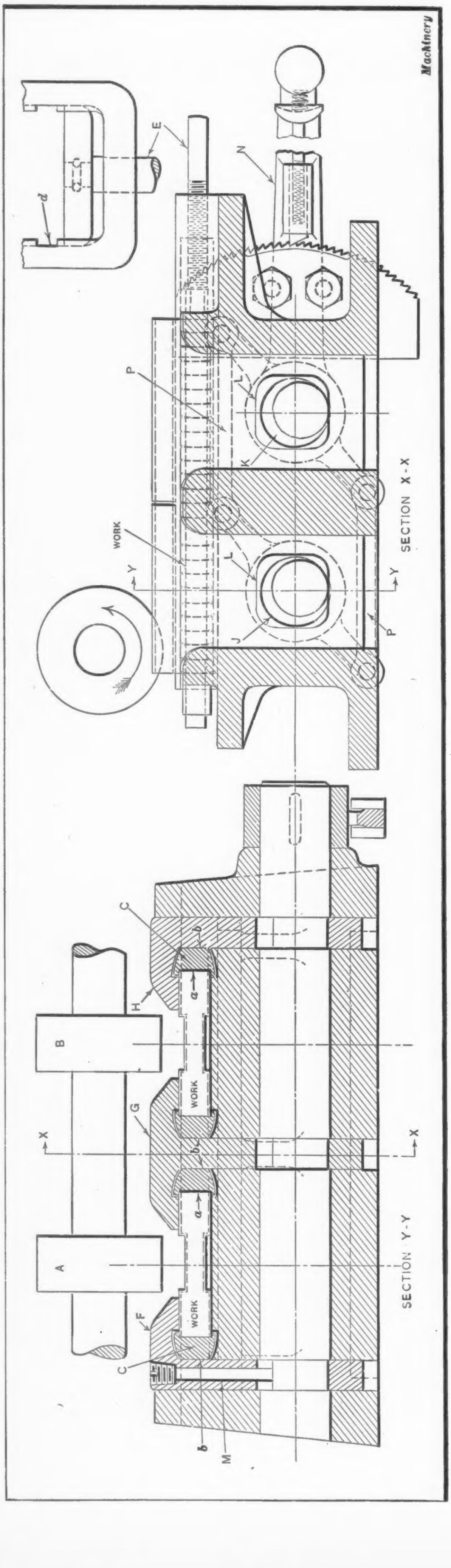


Fig. 4. Milling Fixture equipped with Two Work-holding Cages and Clamping Jaws actuated by Eccentric Shafts

It will be noted that the cages are rounded on one end so that they can be easily inserted in the fixture. The clamping jaws *F*, *G*, and *H* bear directly on the work, as there is a clearance between the cages and the fixture on all sides except at the points *b* where they bear against the jaws. This construction insures that the work will be correctly located under the milling cutters. The clamping jaws are actuated by eccentric shafts *J* and *K* which operate in the rectangular openings *L* cut in the clamping jaws. A screw like the one shown at *M* is provided in each of the jaws *F*, *G*, and *H*. The lower ends of these screws rest on the cylindrical surfaces of the eccentric grooves in shafts *J* and *K*, so that when the clamping lever *N* is raised, the jaws will be released from contact with the work. The eccentrics operate simultaneously, as they are connected by rods *P*.

The body of the fixture is made of cast iron, and the cage of steel. The eccentrically operated jaws are of steel and are hardened. This fixture holds 100 pieces, or 50 pieces in each cage. Four cages are provided so that the operator can reload two while the other two hold the pieces that are being machined. The third and fourth operations are, of course, performed in the same fixture, the cages simply being removed from the fixture, turned upside down, and replaced for the fourth operation, after the third operation has been completed.

Gang Fixture with Two Sets of Work-holding Bases

The operation of milling the front face *b*, Fig. 1, is performed on a fixture similar in principle to the one used for the third and fourth operations, as shown in Figs. 7 and 8. The pieces are laid on flat bases *A*, Fig. 7, on which rectangular projections are machined as indicated at *a*. These projections fit into the grooves machined in the work in the preceding operations. The rounded sides of the pieces are placed down on the flat bases, as indicated in the lower view of Fig. 8. The pressure of the side jaws is sufficient to hold the pieces in the proper position for the machining operation. This fixture will accommodate sixty pieces, thirty being held on each of the two flat plates or bases *A*, Fig. 7. Four of these work-supporting bases are provided, as in the previous case, so that one set can be reloaded while the other set is clamped in the fixture. The body of the fixture is made of cast iron and the work-holding bases of machine steel, the latter being casehardened. It is possible to straighten a base of this kind by grinding if it has become warped when hardening. The method of lowering and raising the clamping jaws of this fixture is the same as that employed on the fixture shown in Fig. 4.

Fixture Designed for Finish-milling and Radius-milling

In Fig. 9 is shown the set-up used for finish-milling the surfaces at *a*, *b*, and *c*, and the radius surfaces *d* and *e*, with three milling cutters *A*, *B*, and *C*. The pieces are held on a base which is interchangeable and is so designed that the work will not be disturbed when the base is removed from the fixture and placed in another fixture of similar design for the next operation. The work-holding base shown in Fig. 9 holds sixty pieces. The hold-down clamps *D* and *E* have T-shaped ends which are held down by stirrups actuated by an eccentric shaft. After the stirrups have been drawn down, a key is inserted at each end of the work-holding base to prevent the work from becoming loose during its transfer from one fixture to another. The fixture to which the work is taken next is used in separating the two parts by taking a saw cut at the point indicated by the dotted lines *f*, Fig. 9.

In Fig. 6 is shown the gang milling fixture used for milling the radius *c* (see also Fig. 1). This fixture is used in connection with a regular machine vise. The work is arranged in two parallel rows, two milling cutters *A* and *B* being used to form the ends of the work at *c*. The auxiliary jaw attached to the front jaw of the vise is provided with an extension piece *C* which forms a base that supports the two work-holding cages *D* and *E*. Between the cages and the base of the fixture is an inverted wedge *F* which is

bolted down in such a manner that it is free to move sidewise. Each cage is made of two flat pieces, one having a step at a on which the shoulders of the pieces rest, and the other having a step at one end against which the pieces are clamped by the screws G. In order to facilitate the machining of the fixture, the screws G were mounted on rectangular blocks H having two pivots or trunnions which fit into holes made in the two pieces that constitute the cages D and E. The two pivot-pins have a slight clearance at each side, so that the two bars are allowed a certain amount of looseness or "float."

The ends of the pieces D and E opposite screws G are connected by pins J. The pieces to be milled are put in the cages as indicated in the illustration, and are clamped in place by screws G, after which they are placed in the auxiliary vise jaws. The jaws of the regular vise are then tightened. The slight angle to which the sides of the bars are machined permits the center wedge to draw the cages down and hold them securely in place. This fixture is designed to hold thirty-two pieces, each work-holding cage being made long enough to hold sixteen pieces. The radius at d, Fig. 1, is milled after the operation of milling the

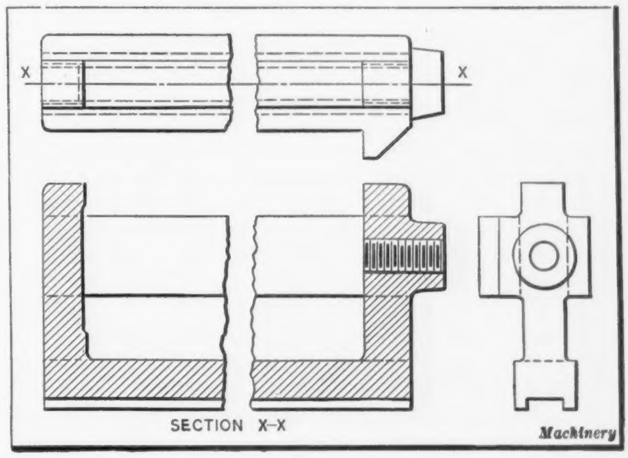


Fig. 5. Sectional View of Work-holding Cage shown in Fig. 3

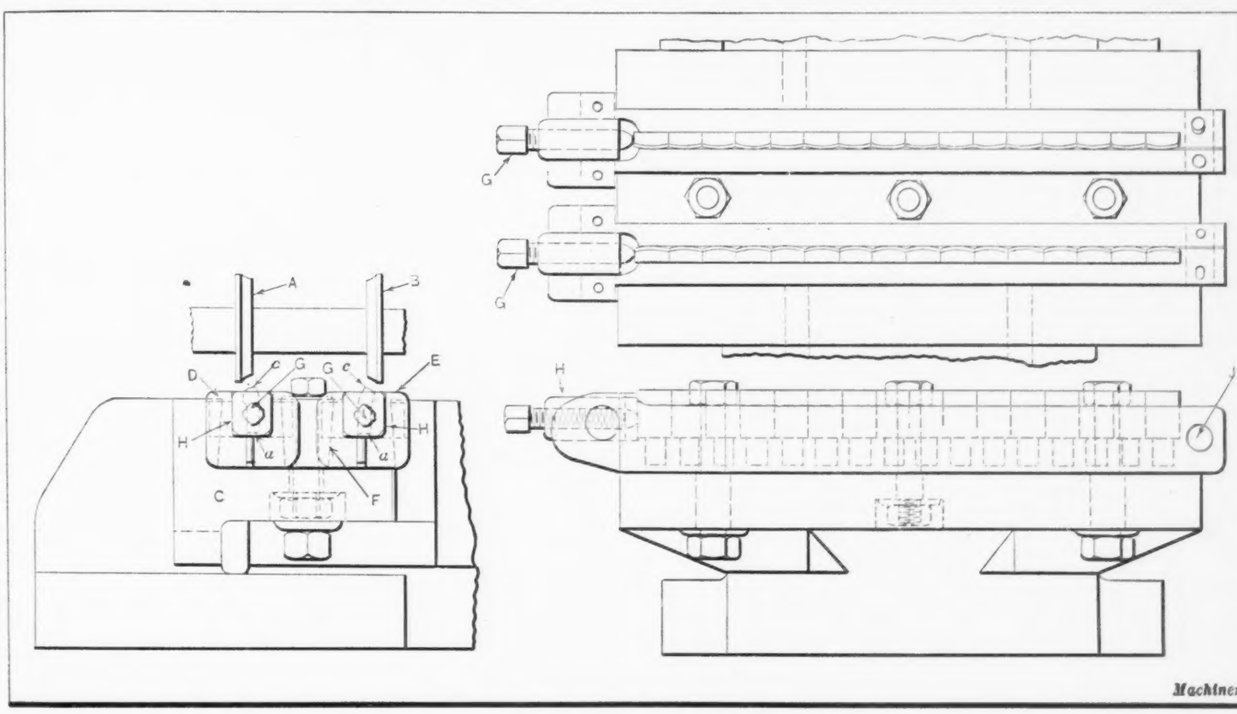


Fig. 6. Fixture employed for Radius Milling Operations

radius c has been completed. Following the latter operation, the hook-end B is bent over as shown. The bending operation is performed in a die, one piece being bent at a time. It was found necessary to bring the parts to a red heat before bending them in the die.

The fixture shown in Fig. 10 is used in milling the dovetail at e, Fig. 1. Both the roughing and finishing cuts are performed while the work is held in this fixture. The roughing cut is made with a regular circular milling cutter which removes the bulk of the stock that forms the dovetail groove e. The second or finishing cut is taken by a beveled end-cutting mill, which forms the dovetail slot. From the illustration it will be seen that the parts constituting the fixture were designed to be used in a regular milling machine vise.

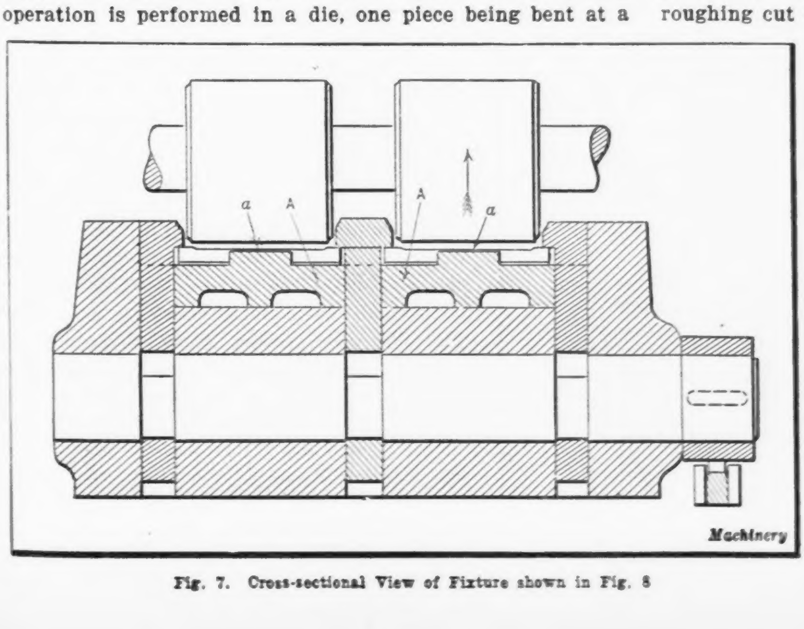


Fig. 7. Cross-sectional View of Fixture shown in Fig. 8

It will be noted that the hook-ends that are dovetailed rest on spacing blocks, one of which is shown at A, Figs. 10 and 11. One of these spacing blocks is provided for each of the twenty pieces held in the fixture. On the top of the holding bar are three small bearings on which the clamp B is pivoted. The short end of this clamp bears on the tops of the hook-shaped ends of the work. When the jaws C and D of the vise are closed, the bar carrying the clamping lever B is drawn down. As the outer end of lever B comes in contact with

jaw *D*, its short end presses against the work so that each piece is forced down until the bottom of the bar comes to rest on the base. This clamping action insures the locating of all the pieces at the same height.

Perhaps the most interesting feature of this fixture is the auxiliary jaw *E* which is shown in Figs. 10 and 12. This jaw consists of separate or individual spring jaws. Each piece of work is pressed or clamped against the spacing block *A*, Fig. 10, by one of these individual spring jaws. Thus the danger of any part becoming loose in the fixture and injuring the delicate dovetail cutter is lessened to a considerable degree. The individual spring jaws were produced by drilling a hole *a*, Fig. 12, the entire length of the solid piece of steel from which the jaw was made. After drilling this hole, the bar was slotted or cut so as to provide as many spring jaws as there were pieces to be held, the slots ending in small holes *b*, which prevents the jaw from cracking during the hardening process.

A flat bar *F*, Fig. 10, is fixed in the longitudinal slot cut in the jaw *E* to prevent the spring jaws from being unduly compressed. It will be noted that the jaws are cut away at *c*, Fig. 12, so that they will not bear against the slender ends of the work. In Fig. 13 is shown the jig used in drilling the holes *D*, *E*, and *F*, Fig. 1, before the pieces have been cut apart. This jig holds two double pieces, the clamping action being obtained by the tapered key *A*. The holes in the pieces are drilled from both sides in order to insure greater accuracy. Four of these jaws are used at one time, two being emptied and filled by an assistant, while the other two are being used in the actual drilling process.

* * *

The leading countries importing American automobiles, for the last year for which complete figures are available, are, in the order of their importance, as follows: Australia, Canada, the United Kingdom, Mexico, Sweden, Argentina, and Spain. In commercial vehicles the order is: Japan, Belgium, Australia, Sweden, Canada, Spain, and Mexico.

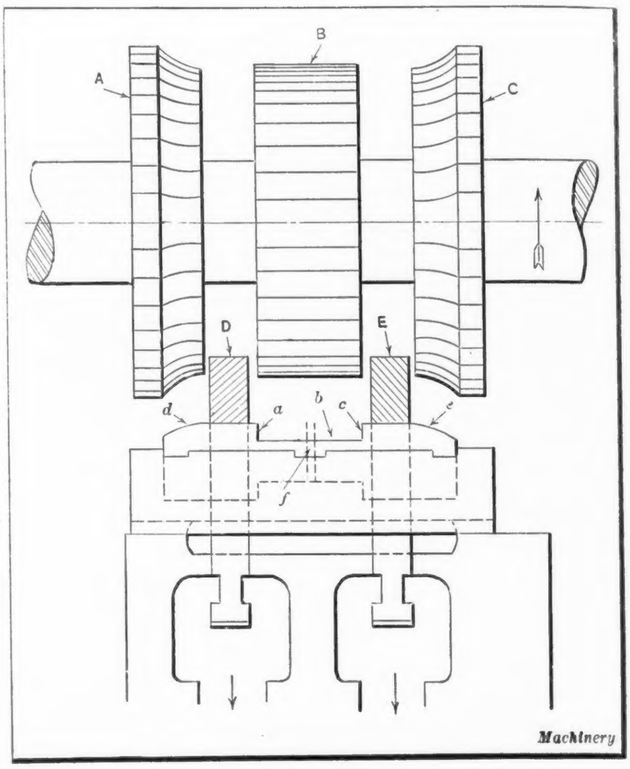


Fig. 9. Milling Fixture provided with Interchangeable Work-holding Base

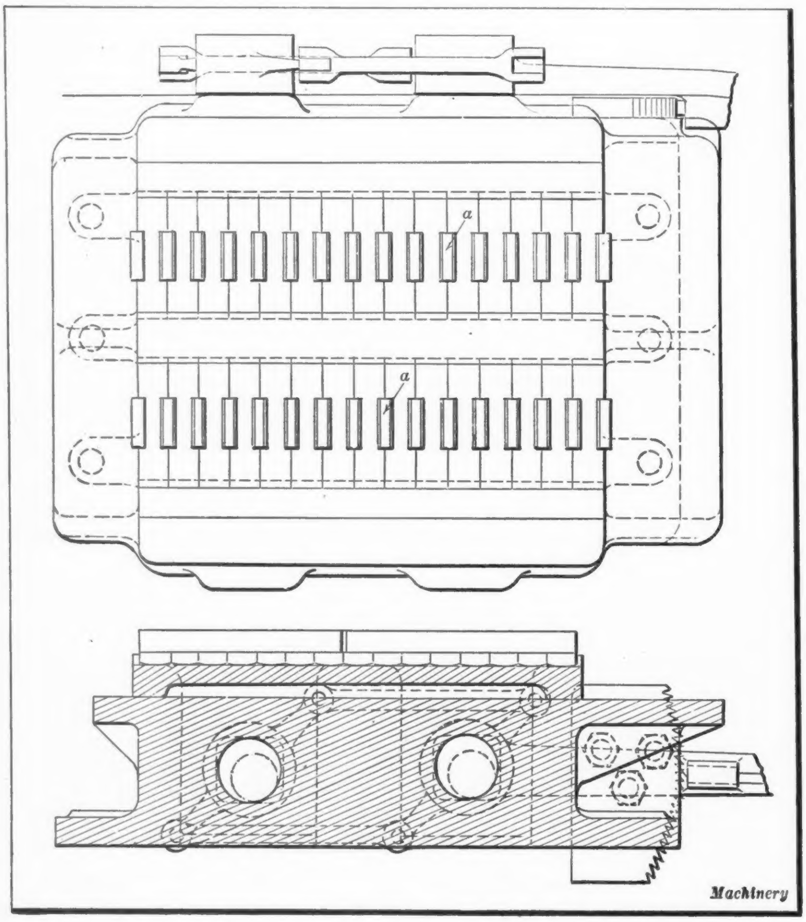


Fig. 8. Fixture provided with Two Work-holding Bases and Lever-operated Eccentric Shafts for actuating the Clamping Jaws

METHOD OF COLLECTING WORK REPORT SHEETS

By FRANK V. FAULHABER

In many machine shops, it is the practice to have all employes, whether paid on a weekly or a piece basis, send daily or weekly reports to the office showing the kind and amount of work done. Where there is a large number of these reports, adequate means must be provided for collecting them.

In one progressive shop, boxes have been provided for each department, in which the workmen deposit their work report sheets. These boxes are collected daily. The boxes are similar to the ballot containers seen at the polls, but they are smaller in size. They are made of tin, are japanned, have a slot at the top to admit the list, and are kept locked. The boxes are conveniently located, so that the workman can deposit his lists without consulting the foreman and will be assured that no curious person can inspect his reports.

In some of the departments, it was formerly the practice to lay the work lists on the foreman's bench, but this required him to spend some of his time in gathering the sheets whenever a clerk from the office came to collect them. With the new method, the clerk simply removes the filled box and replaces it with a new one. From the time the employe turns in his work sheets no one can see them until the box is opened in the office. Before the boxes were installed, some of the men frequently made complaints because of shortages in their pay, and in most of these cases it was found that their lists had not been received at the office. The ballot box idea has proved to be a good and inexpensive one, particularly in machine shops where the men send in a list for each kind of work handled in the shop during the day.

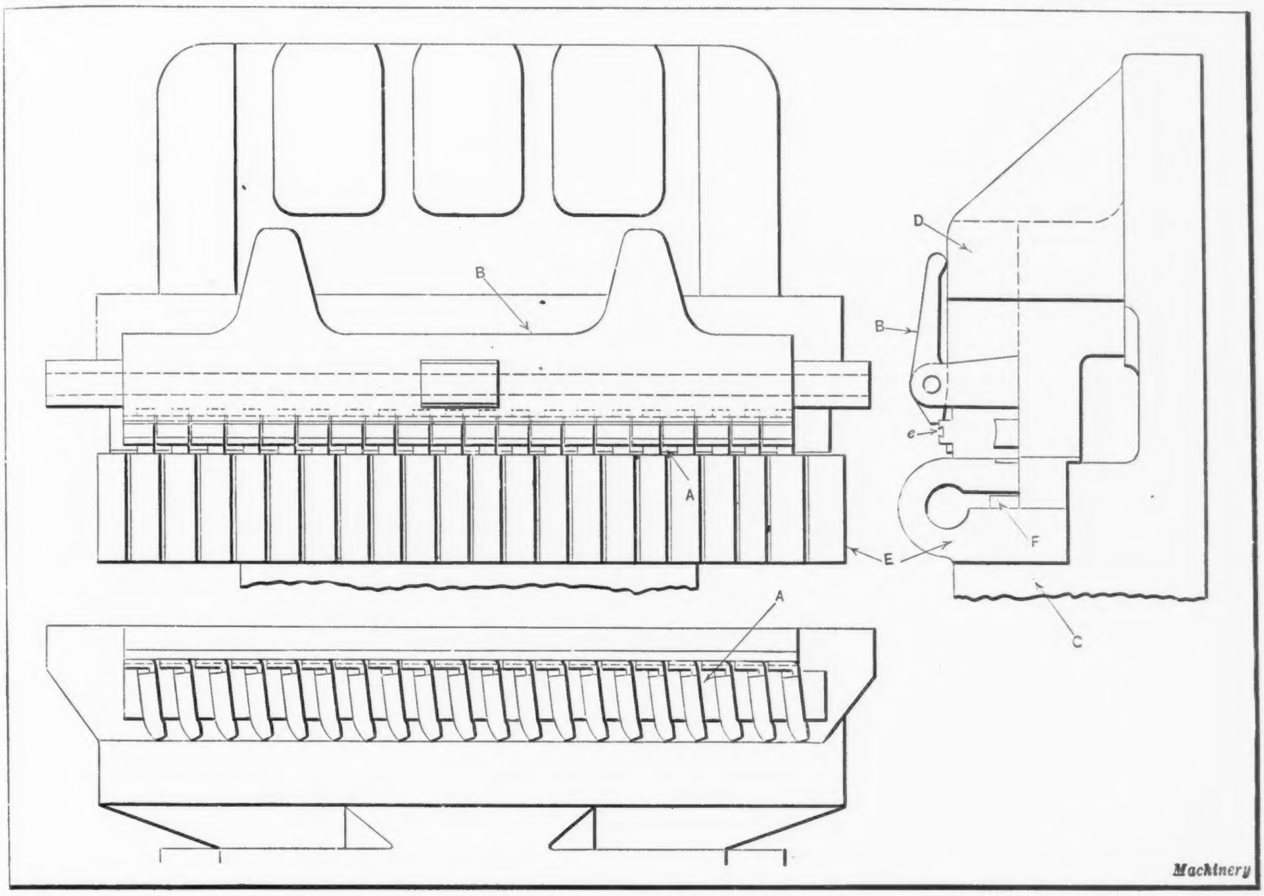


Fig. 10. Fixture in which Individual Spring Jaws and Pivoted Lever are employed to clamp Work

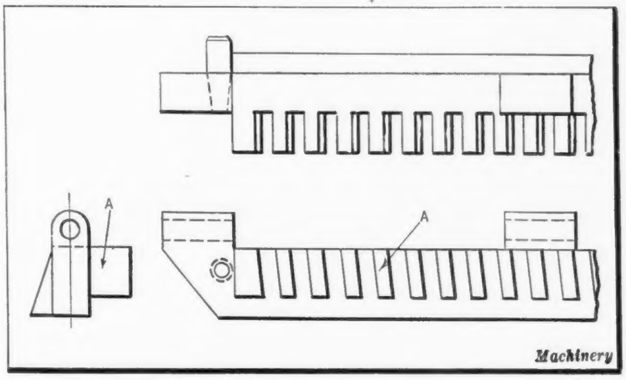


Fig. 11. Auxiliary Jaw of Fixture shown in Fig. 10

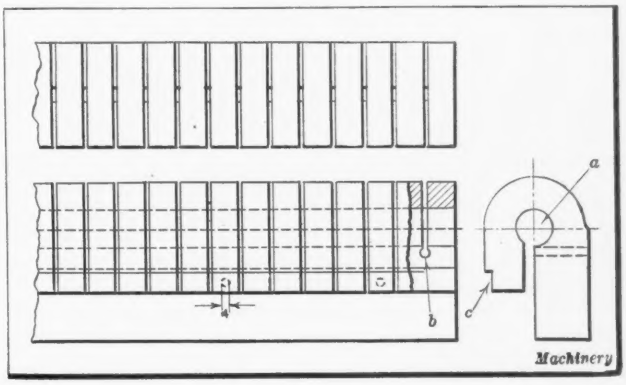


Fig. 12. Individual Spring Jaw of Fixture shown in Fig. 10

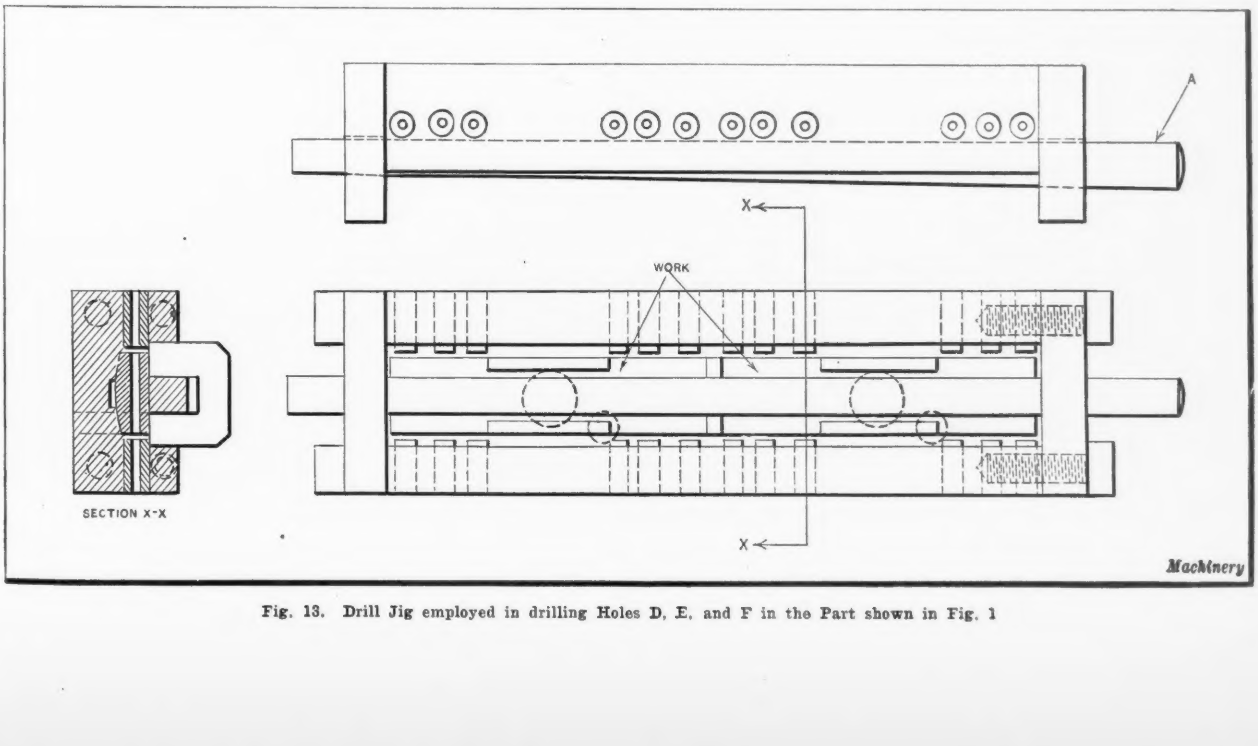


Fig. 13. Drill Jig employed in drilling Holes D, E, and F in the Part shown in Fig. 1

Circular Forming Tool Dimensions

By LYMAN W. CLOSE, President, Lyda Machine Products Co., Toledo, Ohio

ONE of the tool designer's most perplexing problems is that of determining the diameters and angles of circular forming tools for accurate work such as is required in the manufacture of rollers and cones for taper roller bearings, when only a small uniform allowance is left on the formed part for finish-grinding.

Prior to the development of the method here described, the formulas usually found in handbooks were applied, but it was generally necessary to make small alterations in the tool after samples had been cut and the amount of error determined. Furthermore, on account of the wide diversity of shapes and sizes, it was not always feasible to construct hobs for the duplication of tools after the required dimensions had been determined. Neither was it altogether possible to establish a rule for the correction of an error without subsequent correction of the tool, because of the extreme accuracy required.

An infallible method of design was necessary, and after careful analysis of the problem, the method here explained was developed. With this method, forming tools of any shape may be easily designed, and no correction is necessary after the sample pieces have been cut. The position of the center line of the forming tools, to give proper clearance, is assumed to be in the usual relation to the center line of the work, that is, either above or below, depending on whether the cutting edge is above and in front of the center of the work or below and behind the center.

The rake angle will vary with the material to be cut. The softer the material, the steeper must be the rake angle. It is necessary to know, or through knowledge of the conditions to assume, a definite height of the center line of the tool above the center line of the work, the rake angle, the largest diameter of the tool and the dimensions of the work. The explanation that follows applies to a forming tool for making chrome-nickel alloy steel taper roller bearing cones, but the principle involved is applicable to any piece whatsoever, made of any sort of stock, on any kind of screw machine.

Fig. 1 shows the details of a cross-section of the piece to be formed. It will be observed that the profile of this piece includes practically every shape condition that will be met with in miscellaneous designing, and by simple application of the principle involved, the dimensions required for any other shape can be readily obtained.

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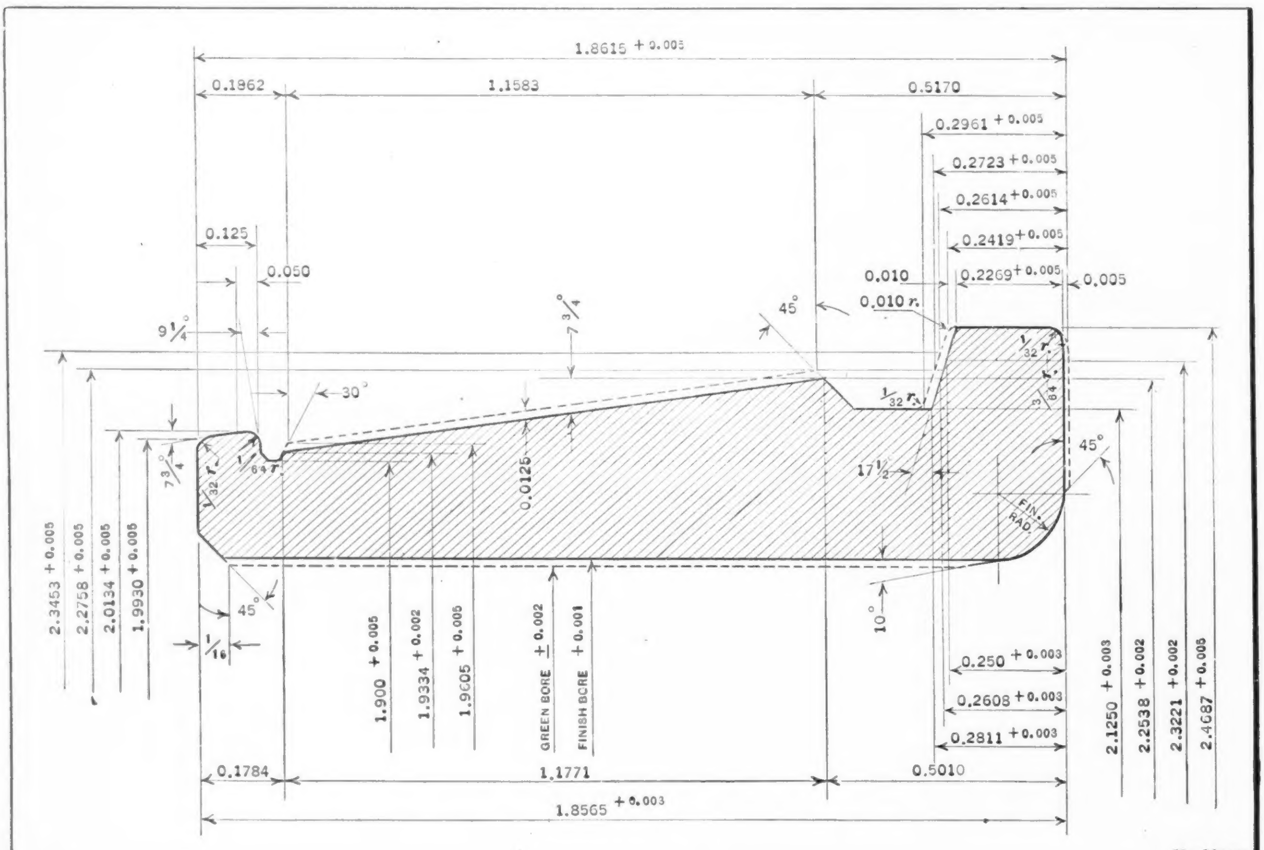


Fig. 1. Cross-section Details of Piece to be formed

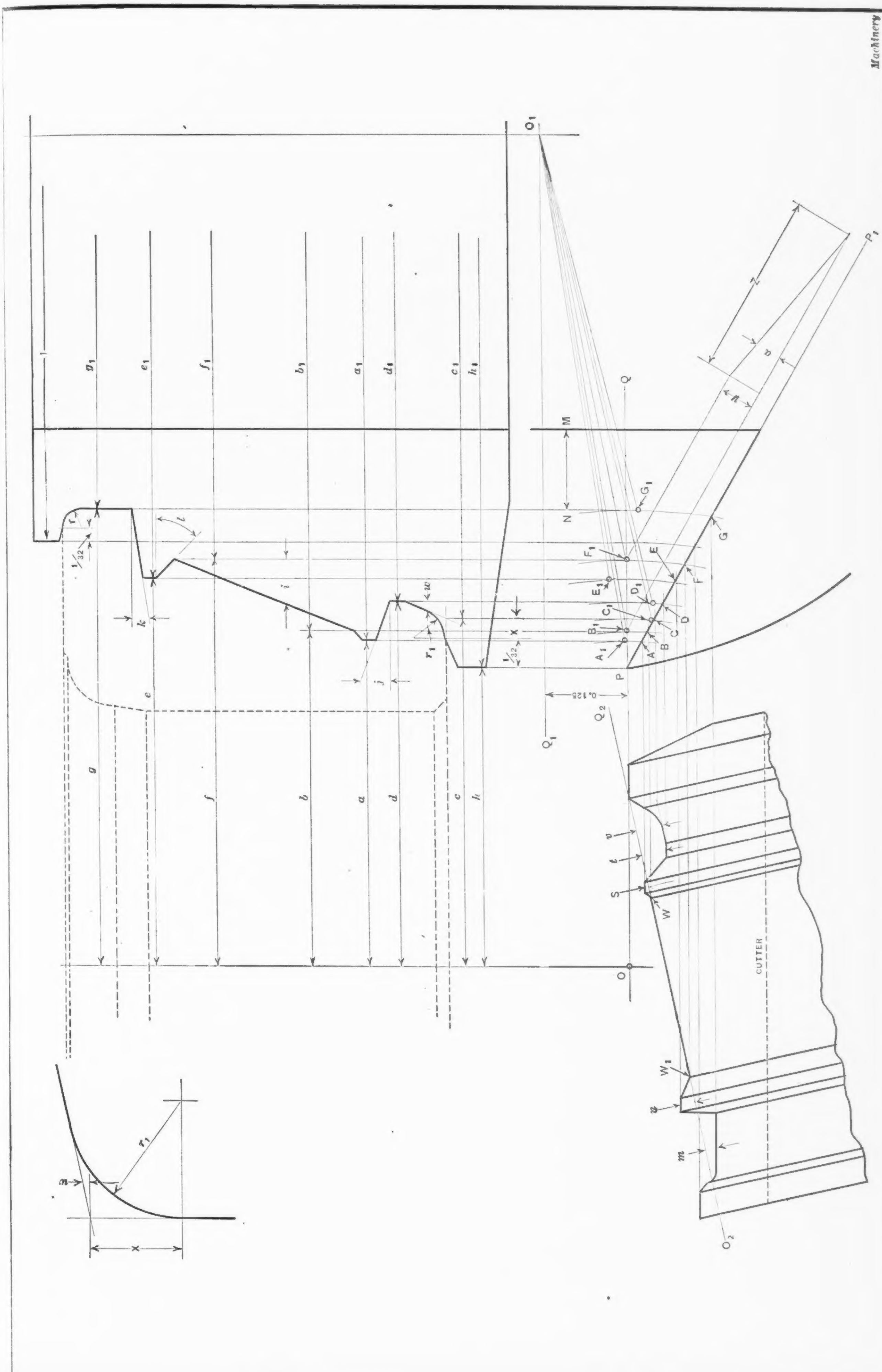


Fig. 2. Lay-out for determining Forming Tool Dimensions

Lay-out for Determining Dimensions

Fig. 2 shows the lay-out by which the dimensions are determined. It will be observed in the discussion that follows, that the dimensions are obtained mainly by scaling the diagram direct, although, of course, mathematical calculations may be made for each result thus obtained, if so desired. The graphical method, however, is by far the quicker, and when the diagram is drawn to a sufficiently large scale, as for instance 10 to 1, the results are quite accurate to the third decimal place, which is satisfactory for all practical purposes.

In this case, the center line of the tool is 0.125 inch above the center line of the work, the rake angle is 15 degrees, and the largest diameter of the tool is 3.5 inches. The tool is designed to form the entire contour of the cone and extend down the face at each end 1/32 inch on a side. The inner face of the tool at A, Fig. 3, which is nearest the headstock, is tapered at an angle of 15 degrees to prevent the tool from dragging in the stock. Now referring to Fig. 2, and using the enlarged scale, draw two horizontal lines OQ and O_1Q_1, 0.125 inch apart. On the upper line assume a point O_1 as the center of the tool, and describe about it an arc at a distance equal to the maximum radius of the tool, cutting OQ at P.

Through P draw the line PP_1 of the rake angle at 15 degrees to OQ. To locate the point O, first lay out the small flange of the cone to a 100 to 1 scale, as shown in the small diagram in the upper left-hand corner, and scale for distance X. Now $h = c - (X + 0.0312)$ which is the distance along OQ from P at which O is located. Now a, b, c, d, e, f, and g are radii of the cone in ascending magnitude. With O as a center, describe arcs through the intersection of the projection of these radii with OQ, cutting PP_1 at A, B, C, D, E, F, and G, respectively.

Project A, B, C, D, E, F, and G to the left or right horizontally, and at some point on the projection of B, assume a point W. Now with W as a center and the projected length of the tapered contact surface of the cone as a radius, describe an arc cutting the projection of F at W_1. Through W and W_1 draw O_2Q_2 which will represent the cutting edge of the tool along the roll contact surface of the cone, when viewed along the line OQ. Now by grinding the rake angle of 15 degrees in a plane inclined at an angle a to the horizontal, points W and W_1 are brought to the same horizontal plane, and line O_2Q_2 becomes parallel to the center line of the tool. This amounts to tilting the tool through the angle a.

Lay off on line O_2Q_2, at their respective distances from W, the various lengths of cone, as shown on the detail in Fig. 1. Draw perpendiculars to O_2Q_2 through the points thus located, cutting the projections of A, B, C, D, E, F, and G. Then through these intersections, complete the profile of the cutting edge as shown.

It will be observed that some of the cutting edges are above and some are below the center line of the work, which is represented by O_2Q_2. Scale the mean distance of each cutting edge above or below this line and transfer these measurements to the arcs through A, B, C, D, E, F, and G at the corresponding distances above or below the line OQ, as the case may be. Denote these points as A_1, B_1, C_1, D_1, E_1, F_1, and G_1, respectively. It should be noted that where the mean distances are taken as m, n, s, and t, the cutting edges are small straight edges intended to generate surfaces on the work parallel to the center line of the work, and the distance v refers to a surface parallel to the main tapered surface. Where other tapers are involved, it is necessary to take the distances from each end of the taper to O_2Q_2 rather than a mean distance, and each distance thus taken must be transferred. Scale the distances from O_1 to A_1, B_1, C_1, D_1, E_1, F_1, and G_1, respectively, which are the correct radii of the tool to produce the shape shown in Fig. 1.

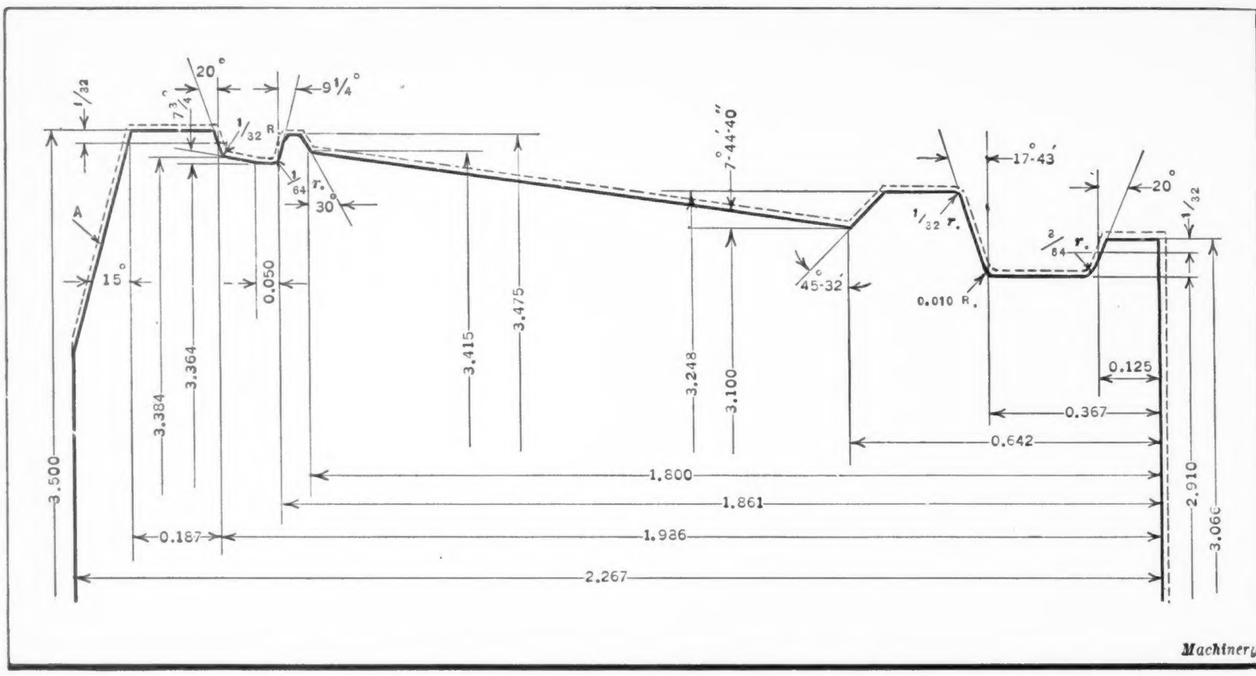


Fig. 3. Profile of Tool for forming Part shown in Fig. 1

The stud used will determine the diameter of the hole in the tool. When this hole is large or the tool is small, it is sometimes found that the distance NM is less than 0.218 inch. If this is the case, the radius h_1 must be increased, and all other radii increased accordingly, which also necessitates relocating O_1. A distance NM of not less than 0.218 inch is required for proper chip clearance. The radius $J = g_1 + r + 0.0312$ inch. This completes the radial dimensions.

The angle a is obtained by projecting points B_1 and F_1 parallel to PP_1 and forming a triangle as shown, making Z equal to WW_1.

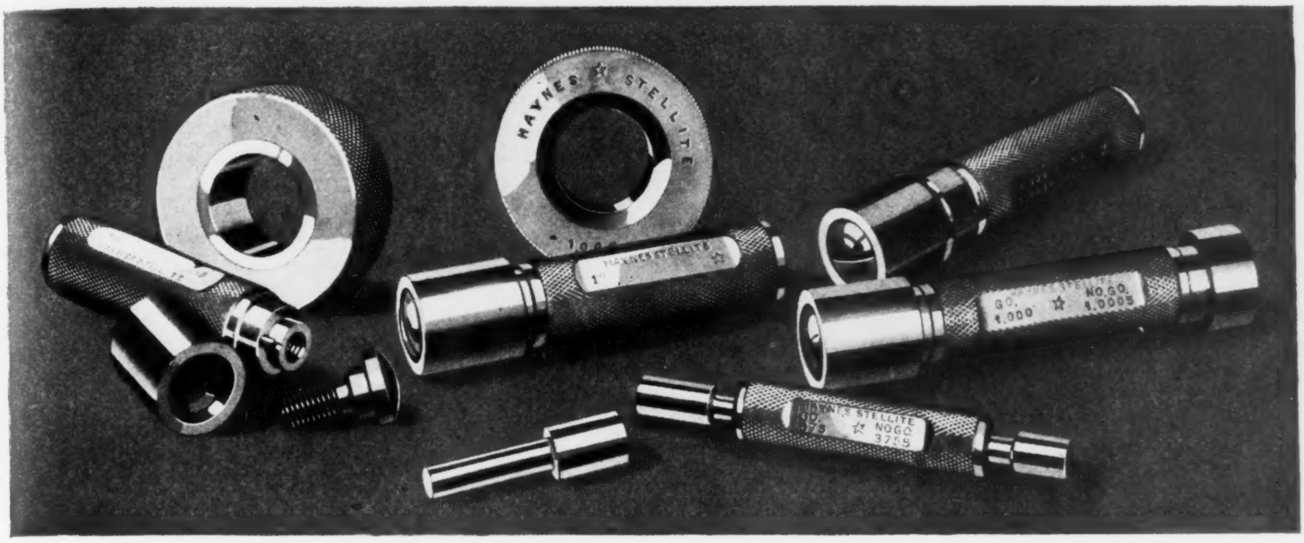
$$\text{Now } y = (f - b) \sin 15 \text{ degrees}$$

$$\text{Tan } a = \frac{y}{Z} \text{ and tan } i = \frac{b_1 - f_1}{Z}$$

Also

$$\text{Tan } k = \frac{S - t}{e_1 - g_1} \text{ and tan } l = \frac{f - e}{e_1 - f_1}$$

because this angle on the work is 45 degrees. Otherwise, this angle should be figured, the same as angle k. Angles j and w are not important, and can be made the same as shown on the detail of the piece.



Stellite as a Material for Gages

An investigation was recently conducted under the direction of the United States Bureau of Standards to determine the adaptability of stellite as a material for gages. While the complete results of this investigation have not yet been published, the following statement is abstracted from a report of the director of the Bureau of Standards:

"In cooperation with the manufacturer of stellite and a number of users of gages, an investigation has been carried on to determine the suitability of stellite as a material for gages. A number of stellite gages were made to the drawings furnished by the users, and the gages were used by them in actual inspection in comparison with steel gages. Reports have been received from all of the users, and these reports show that stellite wears from four to six times as long as the usual hardened steel gage."

Other Advantages of Stellite Gages

In addition to having a longer life, as stated in the report, stellite gages have the advantage of being non-corrosive. In the plant of the Haynes Stellite Co., Kokomo, Ind., stellite gages are used for inspection purposes in a room where parts are marked by electrolytic processes, and the acids have no injurious effect on the gages.

The manufacture of stellite gages has now been developed to the point where it is on a commercial basis, and the manufacturing costs are comparable with the cost of making steel gages. Grinding costs are about the same as for steel, but lapping costs are a little higher due to the greater resistance of stellite to abrasion.

As the blanks are cast to shape, turning, boring or facing operations are not necessary. Likewise, the gages require no heat-treatment at any stage, due to the fact that the metal is inherently hard. Consequently, stellite gages are not subject to the dimensional changes that heat-treatment causes in steel gages. An electrolytic process has been developed for marking stellite, and this operation is easily and cheaply carried out.

Fig. 1. Commercial Snap Gage with Stellite Gaging Pins and Base

Using Stellite for Gaging Stellite

At the Haynes Stellite plant, a number of stellite gages have been applied with satisfactory results to the inspection of other parts made from the same metal. For instance, in the grinding department, steel gages of a certain type that had to be renewed every three weeks because of wear from constant use, have been replaced by stellite gages that last approximately six months. These are ¾- and 1-inch plug gages employed for inspecting holes on which the tolerance varies from 0.0004 to 0.0005 inch.

In the final inspection of stellite blades for milling cutters of the inserted-blade type, an amplifying gage is used. The rubbing of the stellite blades on the steel table of this gage formerly wore the table so rapidly that it had to be trued once for about every 2000 pieces gaged. To remedy this condition, a stellite slab was welded to the table and now the table needs truing only once for every 12,000 pieces. On the same gage the steel ball was replaced with a stellite ball, which resulted in increasing the life from eight to ten times. Fig. 1 shows a commercial snap gage which has a stellite slab welded to the base and which has also been provided with stellite overhead gaging pins. The base and pins were originally made of steel. Stellite plates have also been welded to the anvils of prestometers that had to be lapped twice a day when made of steel. The anvils are now lapped only once in every three or four days.

In one automobile plant steel plug gages, 3/8 inch in diameter and 15/16 inch long, with a tolerance of 0.0001 inch on the diameter, had a life of from 6000 to 7000 holes. Stellite gages, which were substituted for the steel gages, have already

inspected 32,000 holes, and as the tolerance is only about one-half used up, a life of at least 50,000 holes may be expected. Precision gage-blocks made of stellite have been found to compare favorably in constancy of dimension with the best grades of steel. In addition to this, as the stellite gage-blocks are non-corrosive, they need not be wiped off and oiled after using.

Standard Types of Gages

Standard types of stellite gages made by the Haynes Stellite Co. are shown in the heading illustration. The standard sizes range from 1/8 inch up to 3 inches in diameter. The hollow plugs are held firmly to the handles by a lug and screw, and with the exception of the progressive-limit plug gage, are reversible. The handles are made of duralumin, which gives a light, well balanced gage. The ring gages consist of a stellite ring with duralumin cast around it. Special types can be made to suit requirements, and quite a few of such gages have been made by casting or shrinking stellite around steel centers, but the standard types can be used in the majority of cases.

* * *

BASIC PRINCIPLE OF ALLOWANCES AND TOLERANCES

By W. L. HINDMAN

Since first studying the problem of setting allowances and tolerances, the writer has noticed a tendency on the part of most technical men to overlook an important factor on which all men in the shop or those who are in direct contact with production work are agreed, namely, that it is easier to produce shafts having a given tolerance than it is to produce holes of the same tolerance, assuming that conditions in general are the same for both parts. For example, we will assume that the designer decides upon a certain running fit and that the minimum allowance or clearance is to be 0.0005 inch and the maximum allowance 0.003 inch. Since the difference between the two allowances equals the sum of the tolerances of the hole and the shaft, the sum of the tolerances will be 0.003 — 0.0005 = 0.0025 inch. Very rarely will this amount be prorated other than on a "fifty-fifty" basis; thus one-half the amount will be applied to each of the two parts that, when assembled, have the required fit.

Some of the factors entering into the production of two ordinary parts such as just referred to will now be considered with a view to determining if a different apportionment of the tolerances will facilitate production. In general, the diameter of a basic hole is produced by a solid reamer. If all conditions are properly met, however, the hole may be finished by an adjustable reamer, by boring, by broaching, or by grinding.

Conditions to be Considered in Producing a Basic Hole

1. A new reamer nearly always measures over size, being ground to the high limit, and will therefore cut large
2. The diameter of a hole finished by a new reamer is greater than the diameter of the reamer.
3. Slight eccentricities of sockets, sleeves, chucks, spindles, etc., also tend to cause the reamer to cut over size.
4. The minimum machining cost per hole is obtained by setting up tolerances that permit a maximum amount of wear of the reamer before it is discarded.

Conditions to be Considered in Producing Shafts

1. Each shaft is measured with a micrometer by the grinding machine operator, and any variation in size is thus detected. (More shafts are produced by grinding than by any other method and for this reason the grinding method is considered here.)
2. When the proper grinding wheel is used, the wear per shaft is practically constant; hence the working condition of the wheel can be kept uniform with a minimum expenditure of the operator's time.
3. The wear on the grinding wheel is a negligible factor in calculating the production cost of a finished shaft.
4. The minimum cost per shaft is obtained by setting up tolerances that require a minimum amount of time for grinding.

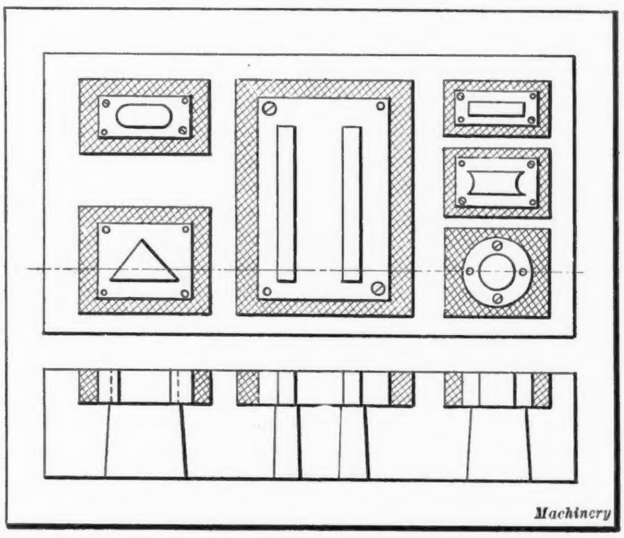
After considering all these factors, which must be dealt with in developing a practical system of allowances and tolerances, the writer incorporated as a basic principle for standard tolerances, the proportion of three-fifths of the sum of the tolerances to be applied to the hole and two-fifths to be applied to the shaft. This would automatically assign a tolerance of 0.0015 inch to the hole diameter and a tolerance of 0.001 inch to the shaft in the case under consideration. This method of apportioning the tolerances has been on trial for seven years, and has amply justified the writer's claim that it will meet the requirements of nearly all manufacturing plants.

* * *

METHOD OF ALIGNING DIES

By CHARLES KUGLER

At one time the writer had charge of the punch and die department in a large gas range manufacturing plant where a roll-operated press was used to punch out the parts of a



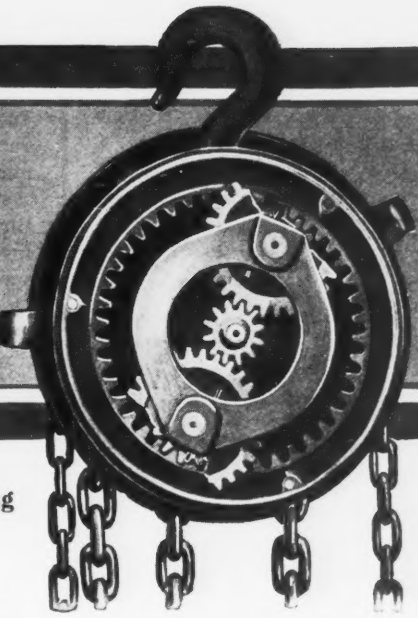
Dies secured in Shoe by Babbitt, Screws, and Dowels

complete gas range at one passage of the roll over the punches. As many as forty-eight individual dies were inserted in four cast-iron die-shoes in the manner shown in the illustration. It was necessary that these dies line up with the punches, which were a sliding fit in the punch-holder. The punch-holder was first laid out, and the dies then made to line up with the holder. At first the depressions were cast in the die-shoe. The sides and bottom of each depression were milled, and the dies machined to fit snugly in their respective depressions. However, the cost of the dies made in this way was so high that the method of entirely eliminating all machine work on the four sides of the dies and also on the sides of the depression was adopted.

With the new method, the depressions in the die-shoe were made larger and machined only at the bottom. After machining the dies to fit the punches, they were placed in the die-shoe. The punches were next placed in the dies, and after properly aligning the punch and die members, babbitt metal was poured around the dies, as indicated in the illustration. Screws and dowel-pins were then used to secure the dies in place. This method of constructing the die member eliminated all machine work on the four sides of the dies as well as on the depression in the die-shoe. The cost of dies made by the improved method was approximately one-third the former cost. The individual dies can be removed from the die-shoe and reground when necessary.

Planetary Gearing

By FRANKLIN DeRONDE FURMAN
Professor of Mechanism and Machine Design
at Stevens Institute of Technology



Applications to Marine Steering Gear Indicator, Rope-making Machinery, Mechanical Paradoxes, Boring-bar Feed Mechanism, and Speed Reducer—Ninth Article

A SIMPLE case of planetary gearing, but with a modified mechanical construction, is used as an indicator on marine steering gear columns. In the illustration Fig. 42, HH_1 is a section of the fixed housing to which the stationary sun wheel D_2 is bolted. Fastened to the main steering column O is a train arm T which carries the planetary wheel pin P. The planet wheel D_3 turns freely on this pin and drives the free wheel D_1, because of the fulcrum action provided by the fixed wheel D_2. The wheel D_3 is a broad wheel, the teeth being long enough to engage both sun wheels D_2 and D_1. The follower D_1 imparts motion to the pointer R. The motion of this pointer is 1/35 that of the steering column O, and its travel is read on a scale marked on the elevated surface I of the housing H. Before presenting the graphical and analytical solutions for this mechanism, the notation used throughout this series will be given:

N = number of turns of driver to one of follower or driven member;

N' = number of turns of follower to one of driver;

N_1 = number of turns of driver to one complete revolution of planet wheel axis;

N_2 = number of turns of follower to one complete revolution of planet wheel axis;

D = diameter of pitch circle of driver, if driver is a toothed wheel; (The driver, or the follower, may be the "train arm" and not one of the toothed wheels, according to the data of a problem.)

D_1 = diameter of pitch circle of follower, if follower is a toothed wheel;

D_2 = diameter of pitch circle of fixed wheel;

D_3, D_4, etc., = diameters of pitch circles of planetary wheels;

T = number of teeth in driver, if driver is a toothed wheel;

T_1 = number of teeth in follower, if follower is a toothed wheel;

T_2 = number of teeth in fixed wheel; and

T_3, T_4, etc. = number of teeth in planetary wheels.

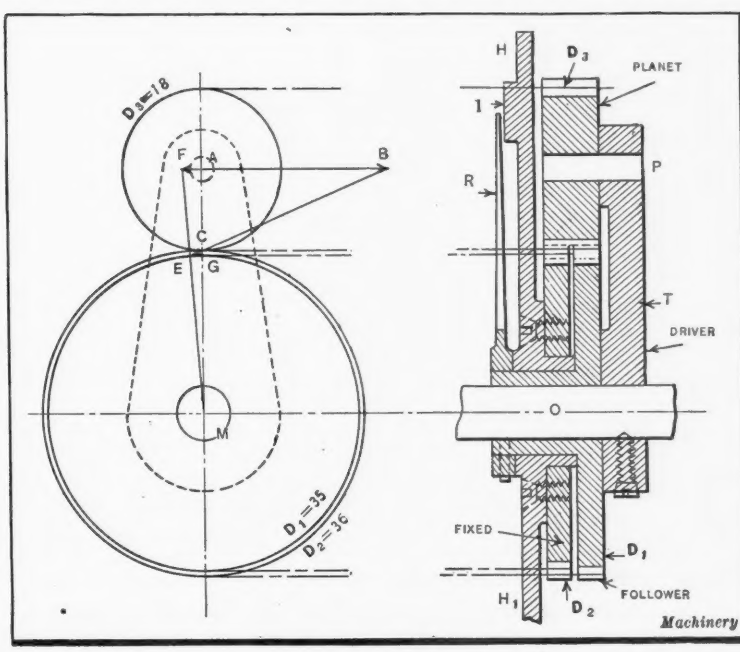


Fig. 42. Planetary Mechanism having a Broad Planet Wheel which engages Both Fixed and Follower Gears

Graphical and Analytical Solutions Applied to Mechanism Shown in Fig. 42

The graphical solution for the modified device (illustrated in Fig. 42), is shown in connection with the diagrammatic end view. The number of turns of the driver (steering column O) to one turn of the follower (wheel D_1 and pointer R) are as $\frac{AB}{-AF}$, or, when drawn to scale and measured, as $\frac{35}{-1}$.

This means that the pointer R has $\frac{1}{35}$ of the angular velocity of the steering column and that it turns in the opposite direction from that of the steering column. The same result is found analytically by the formula

$$N' = 1 - \frac{36}{18} \times \frac{18}{35} = -\frac{1}{35}$$

The only practical effect of the modified mechanical construction, as used in the preceding example, in which one wide planet wheel D_3 is used instead of two separate wheels, is to give incorrect theoretical contact between the teeth of the planet wheel and one of the sun wheels, if the wheels are all cut with ordinary commercial cutters. This would make a theoretical difference in that the pointer R would turn with a quivering action, but the travel of the pointer is so small that this quivering action would not be observable or measurable by ordinary means. However, this theoretical quivering action of the pointer may be entirely eliminated, even where one wide planet wheel is made to engage with both sun wheels, if the teeth on one of the sun wheels are specially cut from a pattern or form that is laid out according to the laws of toothed gearing.

Use of Planet Wheel as Follower

Practical applications of the principles involved when the planet wheel is the follower have long been used in the manufacture of rope to give such internal stresses to yarns, wires, or strands as will cause

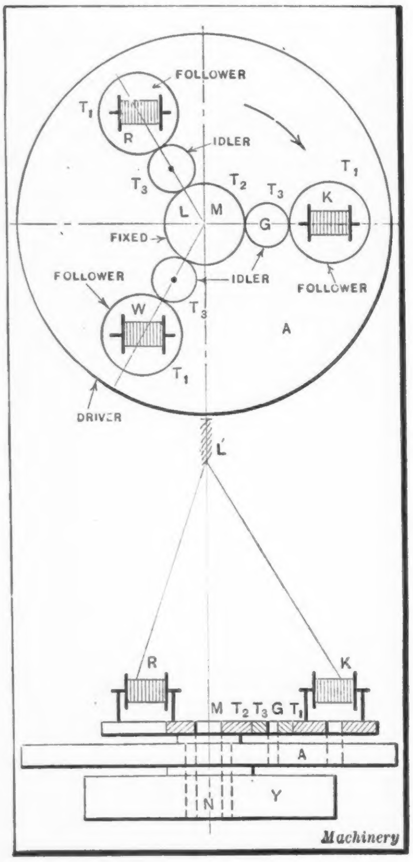


Fig. 43. Diagram illustrating Use of Planet Wheel as Follower on Rope-making Machine

the finished rope to keep its final form and not untwist. In Fig. 43 a wire-rope machine is diagrammatically illustrated, making a three-wire strand for a rope. Three spools are shown at R, K, and W, each spool carrying a roll of wire, and each wire being drawn off its spool and uniformly twisted in with the other two at L in such a way that the twisted wires react against each other to form a balance that maintains the strand in its finished form. Describing the machine briefly, Y is a pedestal and A is a disk which is made to rotate about M–N as an axis. This disk corresponds to the train arm in the ordinary planetary gear problem and is the driver in this machine; T_2 is a fixed toothed wheel; T_3 are idler wheels which are pivoted in A; T_1 are toothed wheels which are also pivoted in A and carry the frame that holds the spools K, R and W. If wheels T_1 and T_2 are the same size, the axis of each spool will have a motion of circular translation as the spool is carried around in its circular path. (For an explanation of circular translation, see Article 4 of this series and Fig. 15). This means that the wire itself will be under a different stress as it takes its "lay" at L in the formation of the strand, from what it would be if the wire were drawn from a spool that did not have this motion of circular translation. By making T_1 greater or less than T_2, the axis of the spool can be given a motion of slight rotation about the axis of wheel T_1 as the spool itself travels in its circular path. This means that the wire may be twisted to any desired degree as it takes its place in the strand at the point L. In all rope making there is a fine art of inducing such stresses in the wire or the yarn, and in the strands as will cause the rope to maintain, of itself, a tendency to remain tightly coiled so long as the elasticity of the material is unimpaired. The method of solving problems of this nature was fully explained in connection with Problem 13 in Article 4.

Ferguson's Mechanical Paradox

This is a device in which gear wheels of equal outside diameter, mounted on one pin, are all driven by another set of intermediate gear wheels of equal outside diameter; yet the final wheels have totally different motions. If there are three wheels in a set, the first may be made to turn slowly forward, the second not to turn at all, and the third to turn slowly backward. The effects produced in this device are based on the principles involved when the planet wheel is the follower, and the mechanism of the "paradox" is but an elaboration of the elementary mechanism, shown in Fig. 15 in Article 4. It may also be regarded as an interesting modification of the Cordelier or rope-making machine represented by the diagram Fig. 43.

The construction of Ferguson's mechanical paradox is illustrated diagrammatically in Fig. 44, where T_2 is a fixed gear wheel; MK is a train arm carrying planet wheel T_3 and three more planet wheels T_4, T_5, and T_6. All four of these planet wheels are keyed to the pin G which turns freely in the train arm. The three planet wheels T_4, T_5, and T_6 are in gear with three other planet wheels T_7, T_8, and T_9, which turn freely on the stud K, fixed in the train arm. The two sets of planet wheels T_4–T_6 and T_7–T_9 are turned to the same outside diameter in order to produce the paradoxical effect, but the effective pitch diameters are different in each set of planet wheels. Also the numbers of teeth in each planet wheel in each set are different, but the number of teeth in one of these wheels differs from the number in the wheel next to it by only one tooth, so that all teeth in all wheels appear to the casual observer to be the same size and form, thus further aiding the apparent illusion. The numbers of teeth adopted for all the gear wheels used in the device, as here illustrated, are as follows: $T_2 = 40$; $T_3 = 40$; $T_4 = 19$; $T_5 = 20$; $T_6 = 21$; $T_7 = 21$; $T_8 = 20$; and $T_9 = 19$.

The graphical solution of the Ferguson mechanical paradox is illustrated in Fig. 44. The train arm is the driver, with a driving handle as shown at A. If this handle is given a linear velocity AB, the pin K will have a linear velocity KL and the pin G a velocity GH. Since the wheels T_3 to T_6 are all keyed to one pin, the point P_2 of wheel T_6 will have a velocity P_2E_2. Solving for the wheel T_9, which is in gear with T_6, the angular velocity of $K = \dfrac{-KL}{KM}$, and the angular velocity of P_2, with respect to its moving center K, is $\dfrac{P_2E_2 - KL}{P_2K}$. Then the number of turns of the planet wheel T_9 per one revolution of the planet wheel pin K is as follows:

$$N_2 = \frac{P_2E_2 - KL}{P_2K} \times -\frac{KM}{KL}$$

The analytical method for solving Ferguson's mechanical paradox is quickly applied as indicated in applying it to find the motion of the planet wheel T_9 as follows:

$$N_2 = 1 - \frac{40}{40} \times \frac{21}{19} = -\frac{2}{19}$$

Therefore the planet wheel T_9 turns with $\dfrac{2}{19}$ of the angular velocity of the train arm, in an opposite and clock-

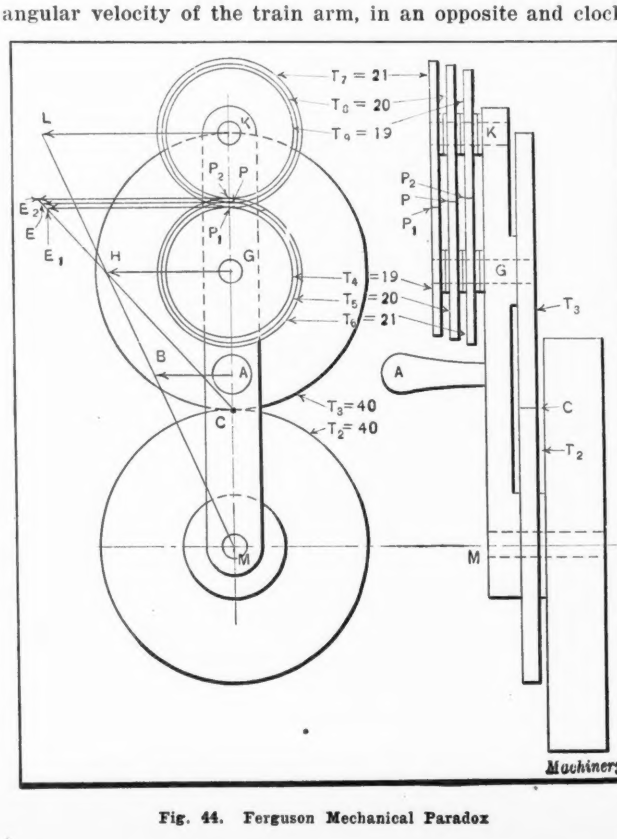


Fig. 44. Ferguson Mechanical Paradox

wise direction. In a similar manner it may be found that the number of turns of wheel T_8 to one of the train arm is zero, or in other words, that T_8 does not turn at all as it swings around the circle; and finally that the planet wheel T_7 makes $\frac{2}{21}$ turn counter-clockwise on its axis K or in the same direction as the train arm, while the train arm turns once about M. The three motions of the planet wheels T_7, T_8, and T_9 each varying only a slight amount from the other, illustrate the practical feature of the cordelier (Fig. 43) in that the bobbin or spool containing the wire, or strand, may be made to turn slightly clockwise, or not to turn at all, as may be desired in the manufacture of any particular rope.

Osborn's Mechanical Paradox

Osborn's mechanical paradox is an application of planetary gearing in which a number of vertical rings or bands are made to turn in the same direction but with different angular velocities, while one vertical ring remains stationary and one or more rings turn in opposite direction to the others, all these motions being obtained with but a single driving point in the mechanism. The paradox is of particular interest in that two of the groups of rings that are all turning in the same direction, receive their motion from the same pinion, one in outside mesh and the other in inside mesh, yet both turn in the same direction. Osborn's mechanical paradox is illustrated diagrammatically in Fig. 45, in section and in top view. A hollow cylindrical base or standard is shown at U with an internal-tooth gear cut on it as at CC_1. At WW_1 are handles of a circular baseplate which corresponds to the train arm. This baseplate carries a free-turning planetary pin, on one end of which is keyed a small spur gear T_{10} which is in mesh with the internal wheel C; and on the other end of the planetary pin is keyed a solid triple cone gear Z, each of these three gears meshing internally with the vertical rings or bands H, I, and J, respectively, and externally with the rings G, F, and E, respectively. There are three sets of these solid triple gears supporting the vertical rings, as shown in the top view.

The kinematic actions in the Osborn mechanical paradox

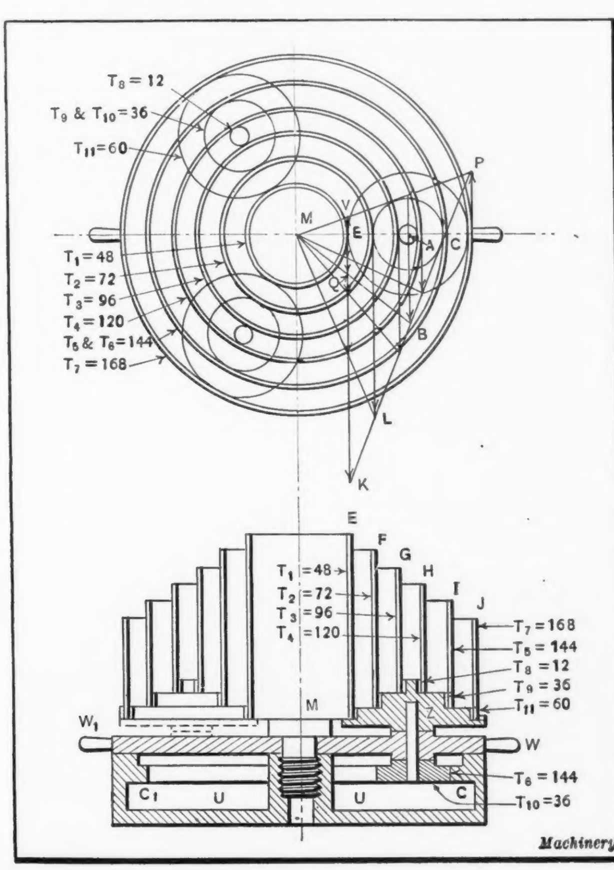


Fig. 45. Osborn Mechanical Paradox

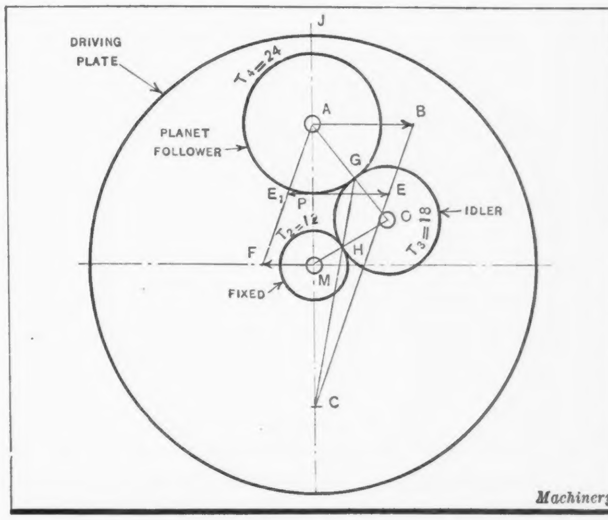


Fig. 46. Planetary Feed Mechanism for Boring-bars

may be solved by any of the three methods. The graphical method is shown in Fig. 45, top view, and is identical with the graphical solutions for the problems in Group 2 in Article 3 of this series. Briefly, the data and solutions are as follows: Assume that there are 12 teeth in the smallest planetary wheel T_8, 36 in T_9, 60 in T_{11}, and 36 in the pinion T_{10}, 48 in ring E, 72 in F, 96 in G, 120 in H, 144 in I, and 168 in J. Since the disk WW_1 is the driver, the pin of planet wheel T_{10} has a linear velocity AB, as shown in the top view. The point C of the triple cone gear is momentarily stationary, and therefore E of the planet gear has the linear velocity EK. This is also the linear velocity of the ring E. Take EM as a unit radius for the purpose of comparing angular velocities, and reduce the driving linear velocity AB to this radius, thus obtaining EQ; EQ and EK may now be read in terms of angular velocity and, consequently, the number of revolutions of the driving plate WW_1 to one of the ring $E = N = \frac{EQ}{EK}$, or the number of turns of the ring E to one of the plate $WW_1 = N_1 = \frac{EK}{EQ}$. The plate and ring both turn in the same direction.

The analytical solution is readily obtained, as in previous problems according to which

$$N_1 = 1 + \frac{T_6}{T_{10}} \times \frac{T_{11}}{T_1} = 1 + \frac{144}{36} \times \frac{60}{48} = 6$$

Solutions similar to those explained will give the relative rates of turning and the directions of turning of all of the rings, with the following curious results, the rate of turning being based on the time required for the driving plate to make one turn, and the direction of turning of WW_1 being clockwise:

Ring E, 6 turns clockwise; ring F, 3 turns clockwise; ring G, 1½ turns clockwise; ring H, 3/5 turn clockwise; ring I, remains stationary; ring J, 3/7 turn counter-clockwise.

Two striking results are obtained; one shows that the rings G and H both turn in the same direction, notwithstanding both are driven by the same pinion T_8, the former ring being in outside gear and the latter in inside gear. It is commonly understood that two gear wheels in outside gear have opposite directions of turning, and that two wheels in inside gear have the same directions of turning. From this it would naturally follow, doubtless, to one not versed in the principles of planetary gearing, that the two wheels G and H should turn in opposite directions. The reason they do not so turn is evident to one who understands the velocity diagram or graph in the top view; the reason also appears in the formula used in the analytical method of solution in which the numeral one on the right-hand side of the equation represents the angular velocity,

clockwise, given to ring H by the turning of the train arm plate, WW_1, in a clockwise direction, while the compound fraction $\frac{144}{36} \times \frac{12}{120}$ represents the angular velocity, counter-clockwise, given to H by the fixed wheel T_8 which acts as a fulcrum. Since the compound fraction just used is less than unity, the turning rate given by the train arm plate predominates, with the result that the ring H turns clockwise, the same as the ring G.

The second result referred to in the preceding paragraph is that the ring I remains stationary while the rings H and J on each side of it are turning in opposite directions. This result may be explained in three ways; first, by writing the graphical result, as explained in the previous problem in which

$$N = \frac{EQ}{EE} = \frac{1.6}{0} = \text{infinity}$$

or

$$N_1 = \frac{EE}{EQ} = \frac{0}{1.6} = 0$$

Second, by writing the analytical formula in which

$$N_1 = 1 - \frac{T_6}{T_{10}} \times \frac{T_9}{T_5} = 1 - \frac{144}{36} \times \frac{36}{144} = 0$$

or, the counter-clockwise component of motion coming from the fixed wheel T_6 just equals the clockwise component of motion coming from the train arm drive plate WW_1.

Third, by an inspection of the mechanism, Fig. 45, which shows that the internal wheel T_6 is stationary and, consequently, that point C of the planet wheel T_{10} is stationary. Since T_{10} and T_9 are keyed together to form one rigid member, and since T_9 equals T_{10}, the point under I on T_9 must also be stationary. As it is this point that is in driving contact with the ring I, and as the point is stationary, the ring I must be stationary.

Planetary Feeding Mechanism for Boring-bar

In Fig. 46, MJ represents the radius of a section of an end plate of a boring-bar turning on an axis at M. At M there is a stationary spur gear with 12 teeth. An 18-tooth idler T_3 turns on a pin in the end plate and transmits motion to the 24-tooth spur wheel T_4 that is keyed to the end of the feed-screw rod which gives the travel to the cutter-head. The problem in this case is to determine how many turns the feed-screw makes on its axis A while the boring-bar turns once on its axis M.

The graphical solution of this problem is found by drawing AB to represent the angular or linear velocity of the bar. Then AB is also the resultant linear velocity of the center A of the follower planet wheel T_4. The resultant linear velocity of another point G on the planet wheel is found by considering that the point G on T_3 has a resultant motion about the fixed point H in a direction perpendicular to HG. Then G on T_4 must have the same resultant motion; consequently, by continuing the line GH, which is perpendicular to the motion of G, until it meets the line AM which is perpendicular to AB, the point C is obtained, and this point is the instantaneous axis for the planet wheel T_4. The resultant motion of the point P is then PE, but relative to the point A it is PE_1, which is found by drawing AE_1 parallel to BE. Since AB, the driver's velocity about M, was measured at the radius MA, the follower's velocity must be measured at the same radius, and therefore AE_1 must be continued to F, thus obtaining the velocity MF which is to be compared with AB. The end plate of the boring-bar is turning clockwise, as indicated by AB, and the gear T_4 is also turning clockwise, as indicated by MF, notwithstanding the fact that AB and MF are pointing in opposite directions. From these considerations the answer, as found graphically, may now be written

$$N = \frac{AB}{MF} \text{ or } N' = \frac{MF}{AB} = \frac{1}{2}$$

which means that the cutting tool advances a distance equal to one-half the pitch of the screw thread each time the bar makes one revolution.

The analytical solution for the problem is found in the usual manner by writing the general formula

$$N' = 1 - \frac{T_2}{T_3} \times \frac{T_3}{T_4}$$

and substituting the numerical values given; thus

$$N' = 1 - \frac{12}{18} \times \frac{18}{24} = \frac{1}{2}$$

Hence, the wheel T_4 makes one-half a turn on its moving axis A, while the end plate G of the boring-bar makes one turn.

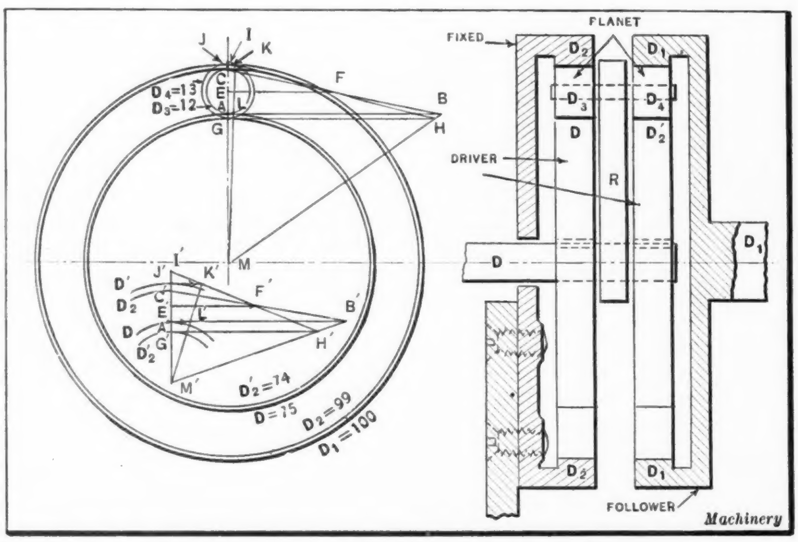


Fig. 47. Two-stage Planetary Speed-reducing Mechanism

A "two-stage" planetary speed-reducing mechanism is illustrated diagrammatically in Fig. 47. The drive shaft D has keyed to it two sun wheels D and D'_2 which have 75 and 74 teeth, respectively. The drive shaft also carries the free-turning train arm R carrying the pins for the planet wheels D_3 and D_4 which have 12 and 13 teeth, respectively. Planet wheel D_3 gears with the fixed internal wheel D_2 which has 99 teeth, and D_4 gears with the follower wheel D_1, which is internal and has 100 teeth. How many turns does the drive shaft D make for one turn of the follower shaft D_1?

This problem differs from the ordinary planetary problems that were illustrated in Group 3 in Article 3 only in the number of wheels employed. One of the extra wheels in the present problem gives the second, or follower planet wheel, an additional motion which varies the line work in the graphical solution slightly, and causes an extra factor to be introduced into one of the formulas for the analytical method. The present problem is, in effect, a combination of the principles in Problems 9 and 14 in Articles 3 and 4.

The graphical solution is shown in Fig. 47, which is drawn to scale to give a true conception of the mechanical arrangement. This adherence to a true scale, however, leads to an unsatisfactory representation of the lines used in the graphical solution, and so these true lines, lettered from A to M, have been reproduced to a distorted scale as shown by lines A' to M', in order that the explanation may be followed more readily. The velocity of the driver is represented by AB. This is also the velocity of point A on the planet wheel D_3 which fulcrums at C against a tooth of the fixed wheel D_2. The velocity of the planet wheel pin is, therefore, EF for D_3, and this is also the velocity of the center of the planet wheel D_4. But D_4 is also driven, at point G, with a velocity GH due to the sun wheel D'_2 which is keyed to the drive shaft.

Since the planet wheel D_4 has two independent drives, at EF and GH, its instantaneous axis I must be found by drawing a line through H and F until it meets the center line. Then point J on the planet wheel D_4 which drives the follower wheel D_1, will be found to have a velocity JK. Reducing this value to unit radius so as to be compared with AB in reading revolutions per minute, it is found that $N = \frac{AB}{AL}$. If this were drawn to a large enough scale and were accurately done, it would be found that $N = \frac{AB}{AL} = \frac{100}{1} = 100$, or, that the drive shaft D makes 100 turns while the follower shaft D_1 makes one turn in the same direction.

The analytical solution for the "two-stage" planetary gear problem is as follows: The number of turns of the driver D for one turn of the train arm R is:

$$N_1 = 1 + \frac{99}{12} \times \frac{12}{75} = \frac{58}{25} = 2\ 8/25$$

and the number of turns of the follower D_1 for one turn of the train arm is:

$$N_2 = 1 - \frac{33}{25} \times \frac{74}{13} \times \frac{13}{100} = 1 - \frac{2442}{2500} = \frac{58}{2500}$$

Having the number of turns of the driver and follower each, per one turn of the train arm, it is only necessary to divide one by the other to find the number of turns of the driver per one of the follower; thus

$$N = \frac{N_1}{N_2} = \frac{58}{25} \times \frac{2500}{58} = 100$$

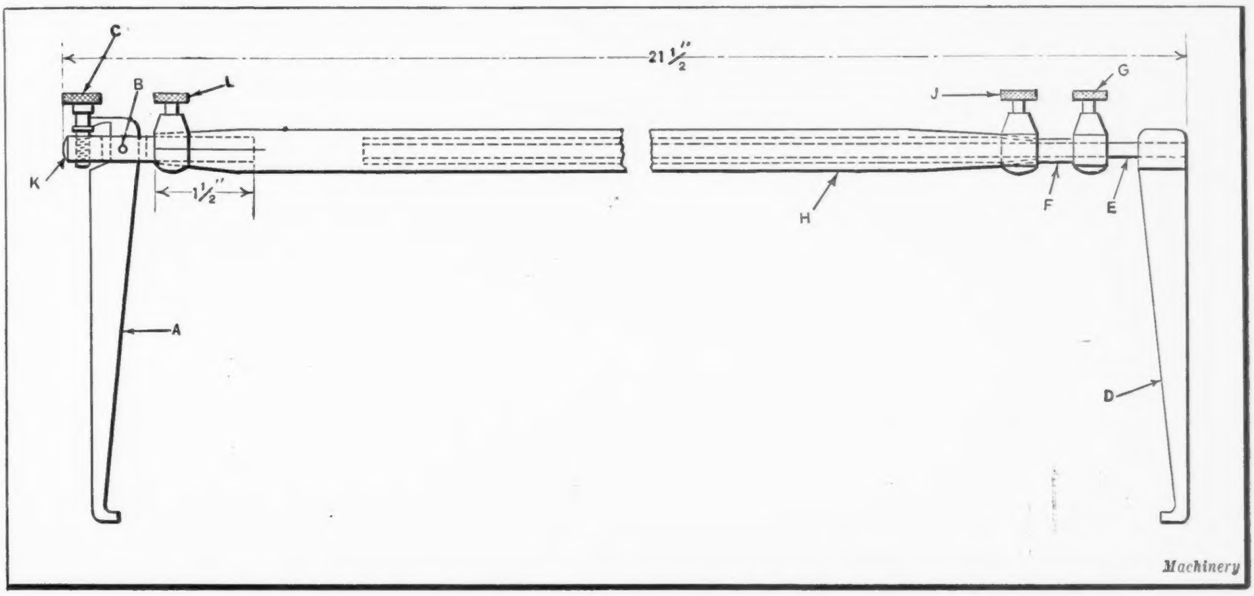
The method of obtaining the factor $\frac{33}{25}$ and the minus sign in the equation for N_2 is as follows: Remembering the analysis for the analytical method, it may be pointed out that when the entire mechanism is turned once about the central axis M to obtain the first elementary step $N_1 = 1$ in the development of the formula, that the wheel D'_2 is also turned once in a clockwise direction. Since D'_2 is keyed to D, it will have the same number of turns as D, per one revolution of the planet wheel pin, and, therefore, D'_2 will turn 2 8/25 times, as found previously, while the planet wheel pin turns once. But when the planet wheel pin was turned once, D'_2 was also turned once, and therefore it now has only 1 8/25 or $\frac{33}{25}$ turns yet to make while the planet wheel pin remains stationary. Since D and D'_2 are driving clockwise, D'_2, while making its remaining 1 8/25 turns, will cause D_1 to turn counter-clockwise; hence the minus sign in the equation used for N_2.

* * *

CALIPERS WITH ADJUSTABLE TELESCOPIC FRAME

By JOHN FITZGERALD

The calipers shown in the accompanying illustration can be adjusted a maximum distance between the gaging points of 4 feet 6 inches. These adjustable calipers have proved very useful in calipering work machined on boring mills, planers, and lathes. Calipers of similar design can be made for work of practically any size, but for larger work the size of the various parts must be increased proportionately. Referring to the illustration, the adjustable arm A is mounted in a slot and pivots on a pin B. Adjustment of arm A is obtained by turning the knurled-head screw C. The fixed arm D is secured to rod E which slides in tube F. The knurled-head screw G provides a means of clamping rod E at any desired position in the tube F. Tube F, in turn, is a sliding fit in another tube H, and can be clamped to it by the knurled-head screw J. The slotted member K in which arm A is secured is a sliding fit inside tube H, and is secured to it by the knurled-head screw L.



Calipers designed to cover a Wide Range of Diameters and Lengths

* * *

DOMESTIC PRICES IN GERMANY

According to the latest issue of *German Trade Reports and Opportunities*, present prices in gold marks for 16 articles in the coal, iron, steel, and metal field averaged 38 per cent higher than during the year immediately preceding the war. The average of 22 industrial manufactured products is 33 per cent higher than previous to the war. Average prices in Germany for 107 articles, including foodstuffs, textiles, leather, coal, iron, steel, and other metals, chemicals, building materials, and manufactured products, is 37.6 per cent higher than pre-war prices.

* * *

Statistics published by the National Automobile Chamber of Commerce, 361 Madison Ave., New York City, indicate that there are over 50,000 automobile and truck dealers in the United States. Public garages number nearly 60,000; there are close to 68,000 service stations and repair shops, and over 64,000 automobile supply stores.

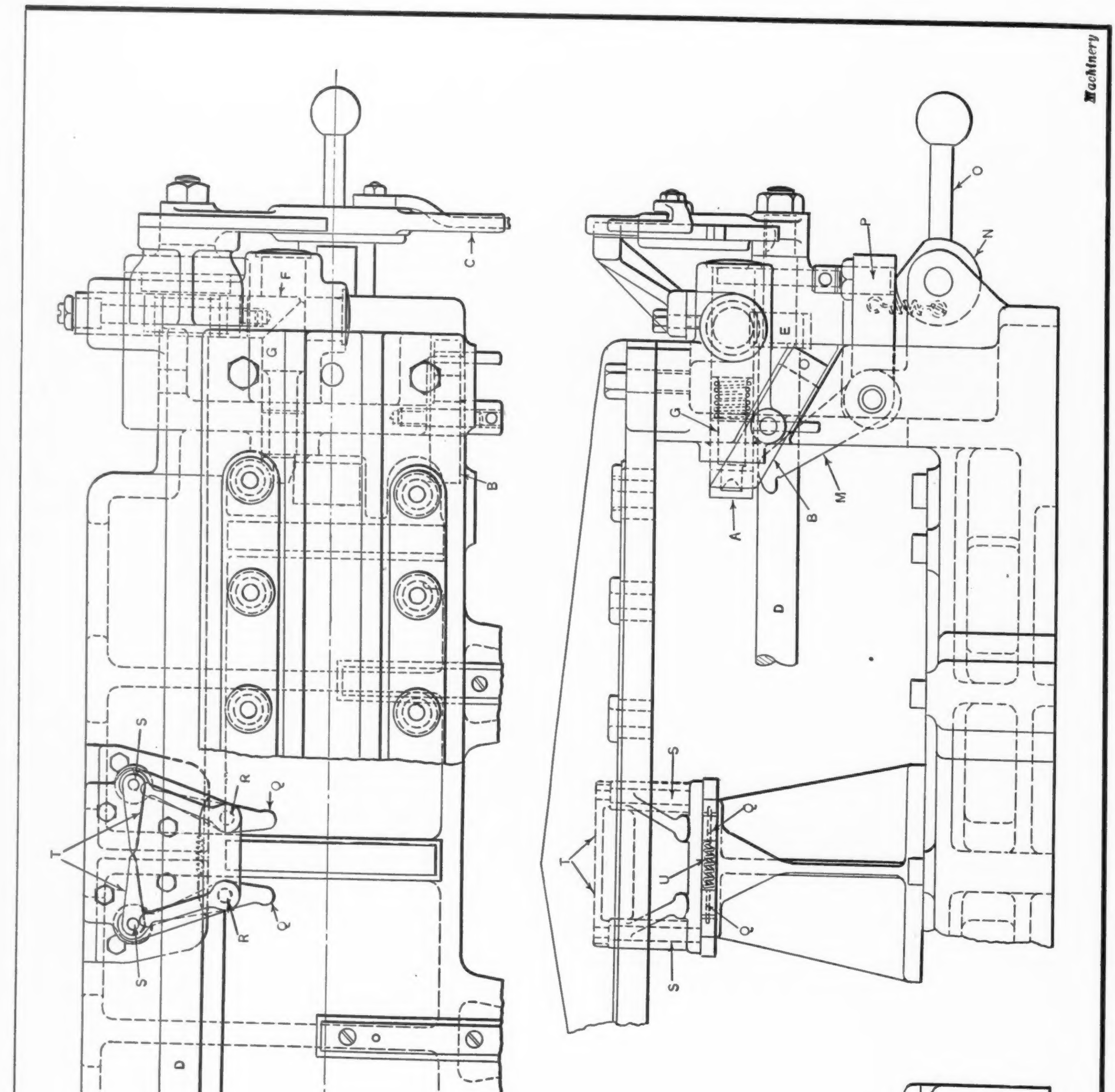


Fig. 1. Jig employed in drilling Sixteen Holes in the Bottom of an Automobile Cylinder Block

Automotive Jigs that Save Time

Design of Several Jigs that have Expedited the Production of Cylinder Blocks

By J. GUSTAF MOOHL, Chief Tool Engineer, Cleveland Automobile Co., Cleveland, Ohio

J. GUSTAF MOOHL was born in Ostersund, Sweden, in 1886, and is a graduate of the Boras Technical College. In 1907 he came to the United States, and was at first employed as designer of standard and special machinery at the H. B. Smith Woodworking Machinery Co., in Smithville, N. J., and at Greenlee Bros. & Co., Rockford, Ill. Later he became sales engineer for the Ingersoll Milling Machine Co., Rockford, Ill., and has also held a similar position with the Beaman & Smith Co., Providence, R. I. From 1916 to 1922 he was chief engineer for the Cleveland Milling Machine Co. and the Cleveland Machine Tool Co. Since 1922 he has been connected with the Chandler Motor Car Co. and the Cleveland Automobile Co.

IN the design of jigs and fixtures, the tool engineer usually has considerable leeway in deciding upon certain factors, such as the general construction of the jig housing, the method of locating and clamping the work and the arrangement of the bushings. It is of primary importance that the work be accurately located and firmly clamped, but it should also be easy to reload the work and clean all dirt from the locating points. Unless a jig is quick-acting it will generally prove uneconomical. In order to insure the best possible design, it is well to think up a number of ways of accomplishing the same results and then adopt the most suitable design. In the cylinder block department of the Cleveland Automobile Co., Cleveland, Ohio, the average reloading time of all jigs is but twelve seconds. The features of several of these quick-acting jigs will be described in this article.

Time-saving Locating Devices

Several ingenious devices which insure that the cylinder block is properly located and which indicate whether it was cast properly in the foundry are incorporated in a jig employed in drilling the holes in the bottom of the block. This is the second operation on the cylinder block; the first operation consists of milling the top side and bottom, and therefore the lengthwise location must be made from rough surfaces. Sixteen holes are drilled in the second operation, two of them with a combination drill and reamer. The two reamed holes are used for locating purposes in subsequent operations. The jig is fully equipped with standard interchangeable slip bushings. In fact, this type of bushing is used wherever possible throughout the shop, over one thousand having already been purchased. This jig can be reloaded in ten seconds.

Location of the cylinder casting transversely in the jig, which is illustrated in Fig. 1, is accomplished by means of two blocks *A* at the ends of the jig, against which the rear wall of the cylinder casting is pushed. It is held against these blocks by means of two clamps *B*. After the casting has been slid into the jig against blocks *A*, handle *C* is operated to swivel shaft *D*, which extends the entire length of the jig. This causes a spur gear at *E* to advance plug *F*, the forward end of which is wedge-shaped and bears against a corresponding end on plunger *G*, as shown in the plan view. Hence, the left-hand end of plunger *G* is forced against the cylinder block. At the left-hand end of the jig there are similar plungers *H* and *J* which are also advanced against the cylinder block through a spur gear on shaft *D*. There is an adjustment on plunger *F* to compensate for wear, but none on the left-hand plunger *H* because this mechanism is of an equalizing design.

When endwise location has been accomplished in this manner, handle *C* is locked in place by pulling lever *K* toward it. To the swivel end of *K* is attached a cam, which is thus brought to bear on a block that, in turn, binds firmly on the plain segment *L*. In this way handle *C* is locked in place until lever *K* is again pushed away from it. In addition to clamps *B*, there are two clamps *M* which are swiveled down on horizontal surfaces of the cylinder block. This particular clamping method is employed on a number of jigs used in this plant. It can be more clearly seen in Fig. 2. Each clamp *M* has a horizontal arm containing a stud *P* which rests on a cam *N*, the cam being attached to

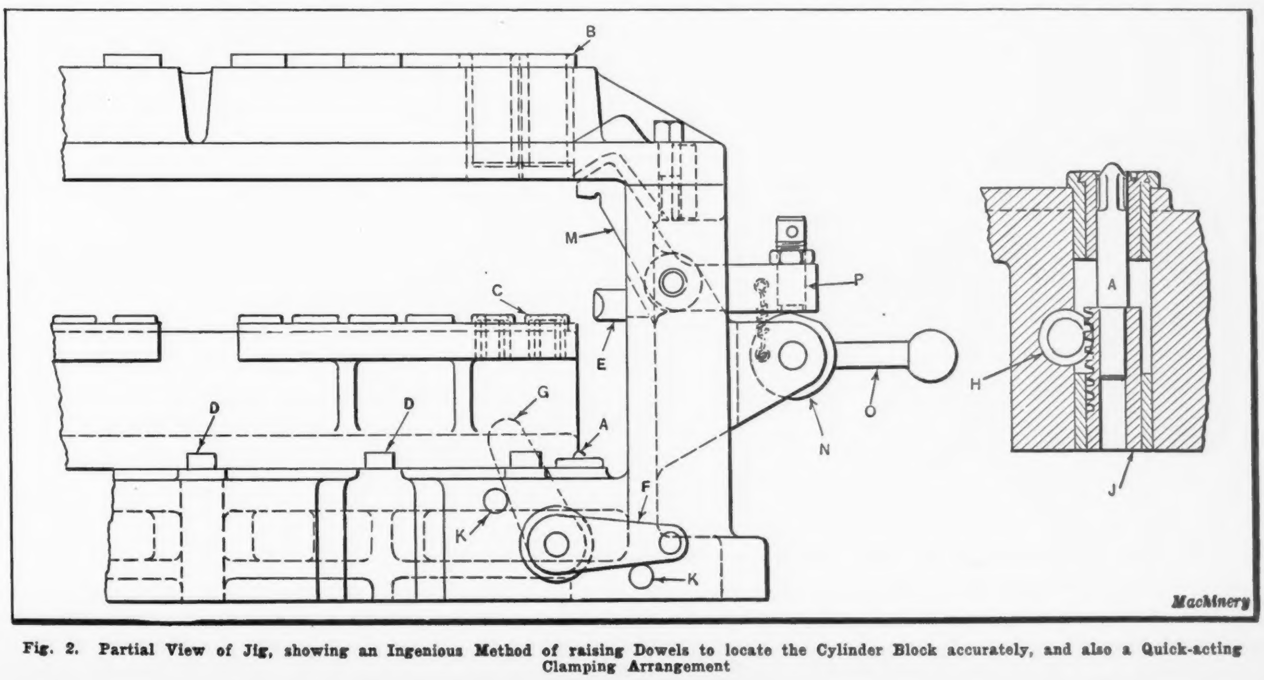


Fig. 2. Partial View of Jig, showing an Ingenious Method of raising Dowels to locate the Cylinder Block accurately, and also a Quick-acting Clamping Arrangement

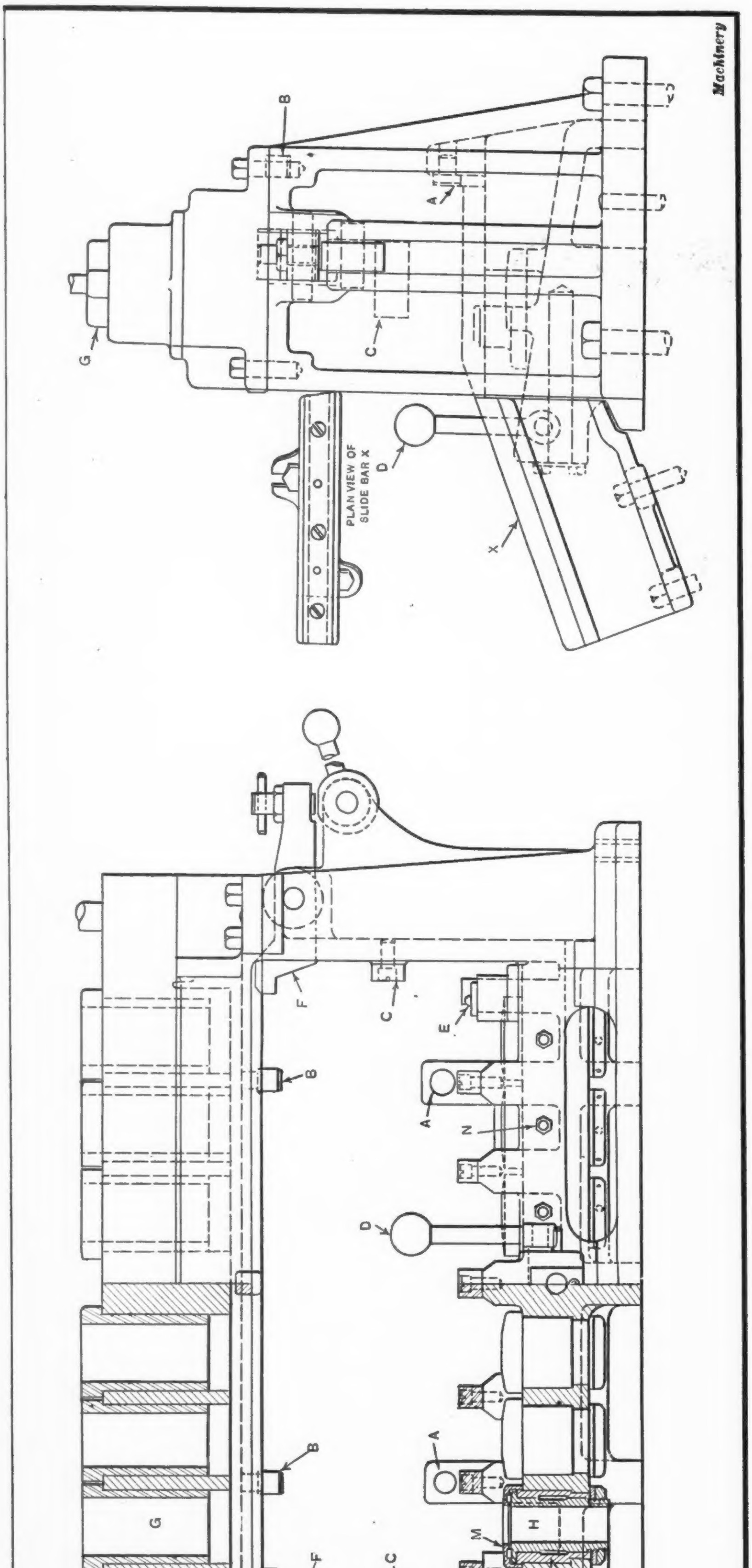


Fig. 3. Jig used on an Inclinable Type of Multiple-spindle Machine for finish-boring the Cylinder Block

handle *O*. To lower the gripping end of clamp *M* on the work, handle *O* is simply pushed down to bring the high point of the cam under stud *P*, causing the clamp to swivel about its fulcrum. When the cam is released, a small coil spring pulls the clamp into the open position. Stud *P* is adjustable to suit variations in the height of the cylinder blocks.

Device that Indicates Whether the Cylinder Block has been Cast Properly

It is important that the two middle cylinders of the block be located approximately in the center of the casting, and so an indicating device has been incorporated in this jig which tells instantly whether the foundry has produced the block within the specified limits. This device is located at the middle of the jig near the back, as illustrated in Fig. 1. There are two arms *Q*, the forward ends of which come in contact with the walls of the two middle cylinders when the casting is slid into the jig. These levers pivot at *R*, and the rear ends engage a slot in a head at the lower end of bolts *S*. Keyed to the upper ends of these bolts are pointers *T*.

If the two middle cylinder walls are central in the jig, there will be an equal pressure on the forward end of levers *Q* and indicators *T* will point toward each other, but if the casting is not central, the pressure on levers *Q* will be unequal, and indicators *T* will not point toward each other. If the cylinder walls are thicker or thinner than normal, the pointers will not be in a straight line but they will point toward each other, provided, of course, that the casting is true. When the casting is removed from the jig, spring *U* sets the device in neutral. Levers *Q* have a large leverage so that slight differences in the location of the cylinder walls will exert considerable influence on studs *S*.

Throughout the cylinder block department, the design of the different jigs has been kept as closely alike as possible, and in a number of cases the only substantial differences are in the arrangement of the jig bushing plates. Five jig bodies, for instance, were cast from the same pattern as that used for the jig just described. The economy of this method is apparent.

Dowels Lowered into the Jig Body for Protection in Reloading

In several jigs used subsequently to the one just described, dowels are entered into the two reamed holes of the cylinder block. These dowels must be lowered into the bottom of the jig before a block can be loaded or unloaded. They are raised into the holes of the cylinder block after the block has been positioned approximately, and thus serve to locate it accurately. The jig shown partially in Fig. 2 is equipped with two of these dowels, one of which may be seen at *A*. This jig is used in reaming the valve seat and valve guide holes of the cylinder block. Each tool is piloted by an overhead bushing *B* and an underneath

bushing C. All bushings in this jig also are of the standard interchangeable type. The tools consist of a 1 3/8-inch reamer, which has a standard taper shank and a socket in the reamer end which receives the shank of another reamer 15/16 inch in diameter. On the lower end of this second reamer there is a pilot that enters the bottom bushing.

The cylinder block is laid on five hardened and ground strips D, and slid against a button on each end of the jig at the back to position it approximately transversely. A pin E on each end of the jig locates it lengthwise. Two handles F are then raised to the position indicated by the dotted lines G to bring dowels A up into the reamed holes in the work. On the same shaft as lever F there is a spur pinion H, as shown in the sectional view, which engages the rack teeth of sleeve J. Dowel A is attached to this sleeve and raised and lowered with it. Even the dowels are guided by standard interchangeable bushings, as they can be easily removed to permit the mechanism to be quickly disassembled. By having the dowel and rack sleeve separate, it is more convenient to replace the dowel, should this be necessary. The mechanism for raising and lowering the dowel at the other end of the jig is, of course, identical to this.

It will be evident that when handle F is in the position indicated by the dotted lines G, it interferes with loading or unloading of the jig, and in lowering the handle, of course, the dowel is withdrawn. This design obviates damage to the dowels. Both the raised and lowered positions of the handle are governed by stop-pins K. The reloading time of this jig is about five seconds.

Jigs Used in Finish-boring the Cylinders

One or two unusual features are embodied in the jig used in finish-boring the cylinders, as will be seen by reference to Fig. 3. This operation is performed on a Moline inclinable six-spindle machine. When in place on the machine, surface X of the jig base is in a horizontal position. The casting is approximately located transversely by pins A and B, and longitudinally by blocks C. Then lever D is pulled down to raise two dowels E simultaneously into the reamed holes in the bottom of the cylinder block. In this case only one lever is manipulated to operate the two dowels. On the same shaft as lever D there is a spur pinion which operates a rack on a shaft that extends toward the back of the jig. A second rack on the under side of this shaft drives a pinion on another shaft running lengthwise of the jig. At each end of the latter shaft there is a spur pinion which meshes with rack teeth on the sleeve of the dowels in the same manner as illustrated in Fig. 2. Handle D is again in the raised position when the dowels are raised, and thus prevents loading or unloading of the work until the dowels are lowered. After raising the two dowels, clamps F are lowered on the cylinder block by a mechanism similar to that described in connection with the previous jigs. These clamps can be pulled back horizontally when loosened so as to facilitate reloading. This jig can be reloaded in six seconds.

The boring tools are guided above in bushings G and below in bushings H. The upper bushings are contained in a plate J, suspended from the head of the machine and moved vertically with it. In the descent of the drill head, a pilot K on each side of the jig plate enters a bushing to align the plate with the jig and work. When the jig plate has been seated, the boring-bars continue feeding, the cut commencing after the pilots on the lower end of the boring-bars have entered bushings H.

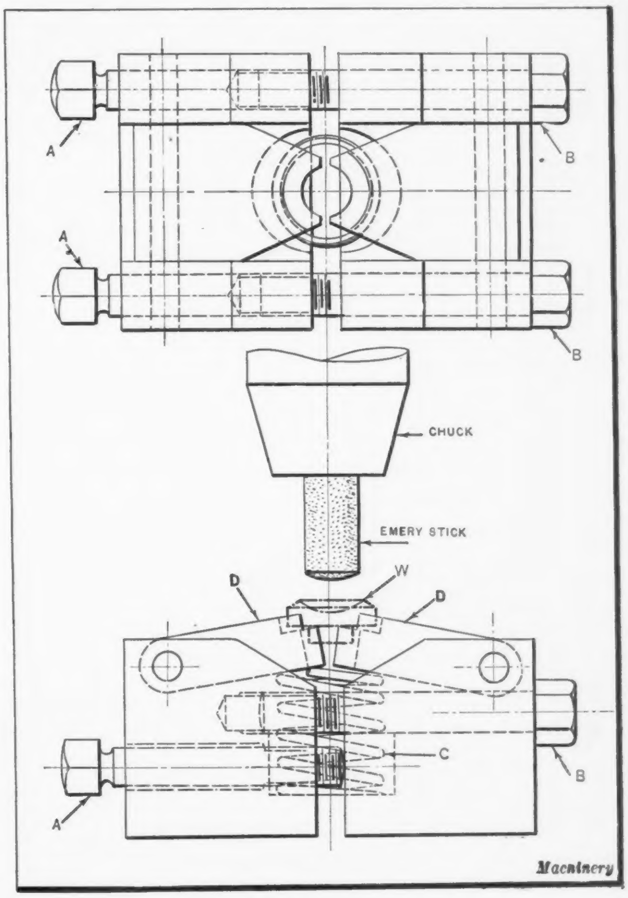
These bushings are of a design that guards against scoring when dirt or chips get between them and the pilot of the boring tools. They are made of hardened steel with the outside tapered to permit adjustment for wear. An outer phosphor-bronze bushing L, which is tapered to correspond, surrounds each bushing H. During an operation, the pilot of the boring-bars runs freely in bushing H until sufficient chips and dirt accumulate between the pilot and the bushing to cause the two to bind. Then bushing H will turn in bushing L and obviate scoring of the bushing or the boring-bar pilot. A packing retained by cover M prevents dirt from getting between the two bushings. The bearing surfaces of the bushings are lubricated by means of a high-pressure oil gun, connected to the different bushings through nuts N.

* * *

GRINDING AND POLISHING FIXTURE

By A. B. CASPER

In the accompanying illustration is shown a grinding and polishing fixture that has been used with very satisfactory results in grinding the hardened steel ball seats used in a drag link. The grinding of the spherical seat was found to be necessary in order to remove the scale and light tool marks left on the piece when it came from the automatic machine. Not having a grinder adapted for this job, it was



Grinding and Polishing Fixture

decided that the work should be done on a drill press in as simple a manner as possible.

It was necessary that the fixture be practically automatic in so far as gripping and releasing the work was concerned, in order to allow the operator to keep one hand on the drill press lever and eject and feed the work with the other hand. It was also necessary that the fixture be so designed that the grit or abrasive dust from the emery stick would not clog up the mechanism. This requirement eliminated the possibility of using a collet such as is generally employed for holding small parts.

Referring to the illustration, it will be noted that the clamping mechanism of the fixture operates on the toggle principle. Pressure on the work W causes the jaws D to close in and grip the work. Increasing the pressure of the grinding stick on the surface being ground serves to tighten the grip of the jaws on the work. By adjusting the screws A and B it is possible to obtain just the right amount of jaw action. When the pressure on the work is released, the spring C causes the jaws to rise and free the work. The ground piece can then be flicked from the fixture with the finger, and another piece dropped in place.

DIE FOR PUNCHING A CIRCULAR SLOT IN TUBING

By FREDERICK W. BECKERT

The die shown in Fig. 2 performs rather an unusual and interesting operation, that of punching the circular slots in a piece of steel tubing like that shown in Fig. 1. These slots are about 5/32 inch wide, and have a radius of about ¾ inch. They are located diametrically opposite each other, as will be evident from the illustration. The pieces of tubing in which the slots are cut are 0.045 inch thick, 1¾ inches in diameter, and 1 15/16 inches long.

The slots are punched one at a time from the inside of the tubing and the burrs left on the outside of the work are removed by a simple polishing operation. Referring to Fig. 2, the die member *A* is ground to fit the outside of the steel tubing. The die opening has a clearance angle of about 1½ degrees. The U-shaped scrap shown at the left of the tubing in Fig. 1 is cut out by the punch *B*, Fig. 2, and is forced down through the die opening and falls through a hole in the bed of the press.

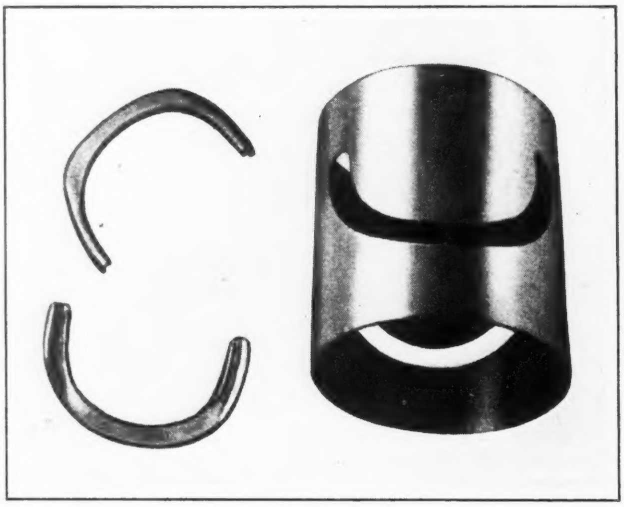


Fig. 1. Steel Tubing and Scrap Stock punched out by the Die shown in Fig. 2

To cut the slots in a piece of tubing, the press operator first withdraws the key *C*, slides the work into place over the punch member *B* so that it occupies the position indicated at *D*, where it is held in place by two spring-actuated levers having pins that enter two previously punched holes in the tubing, one of which is shown at *E*. The tapered key *C*, which is dovetailed to the punch-block *F*, is then slid into place to support the punch, after which the press is tripped and the first slot cut.

As the punch passes through the tube it compresses the stripper and the rubber cushions *G* so that the tube will be stripped from the punch on the upward stroke. As soon as the press ram comes to rest at the end of the upward stroke, the work is indexed one-half revolution and the second slot punched in the same manner as the first. The locating levers referred to (not shown in the illustration) release the pins from the holes *E* in the work when the punch has descended far enough to hold the work in place on the die. Obviously, severe strains are imposed on the slotting punch and the die, but notwithstanding this fact comparatively little time has been spent so far in making repairs or adjustments. At the time the piece shown in the illustration was finished, about 10,500 pieces had been slotted, and the time required for making adjustments and repairs on the punch and die amounted to only about four and a half hours.

* * *

MEN EMPLOYED IN THE AUTOMOBILE INDUSTRY

It is estimated that nearly 3,000,000 people are now directly employed in building, maintaining, and operating automobiles. In this number are not included those engaged in the building of machine tools or other production equipment for the automobile industry, men engaged in construction work of automobile plants, or those engaged in producing materials for the industry. Of the number mentioned, 318,000 are workers in automobile factories; 300,000, in factories making parts and accessories; 115,000, in tire factories; 181,000 are engaged in selling motor vehicles; 135,000 in selling supplies, accessories and parts; and 90,000 in selling tires. There are 345,000 employes in automobile repair shops, and 110,000 in garages. Besides, there are 470,000 professional chauffeurs and 750,000 truck drivers.

* * *

The transportation division of the Department of Commerce has published a book entitled "Packing for Foreign Markets," ($1.25), copies of which may be obtained by application to the Superintendent of Documents, Government Printing Office, Washington, D. C. The book covers the best practices evolved through the experience of some of the oldest American export houses, as well as the results of tests carried out by the Forest Products Laboratory.

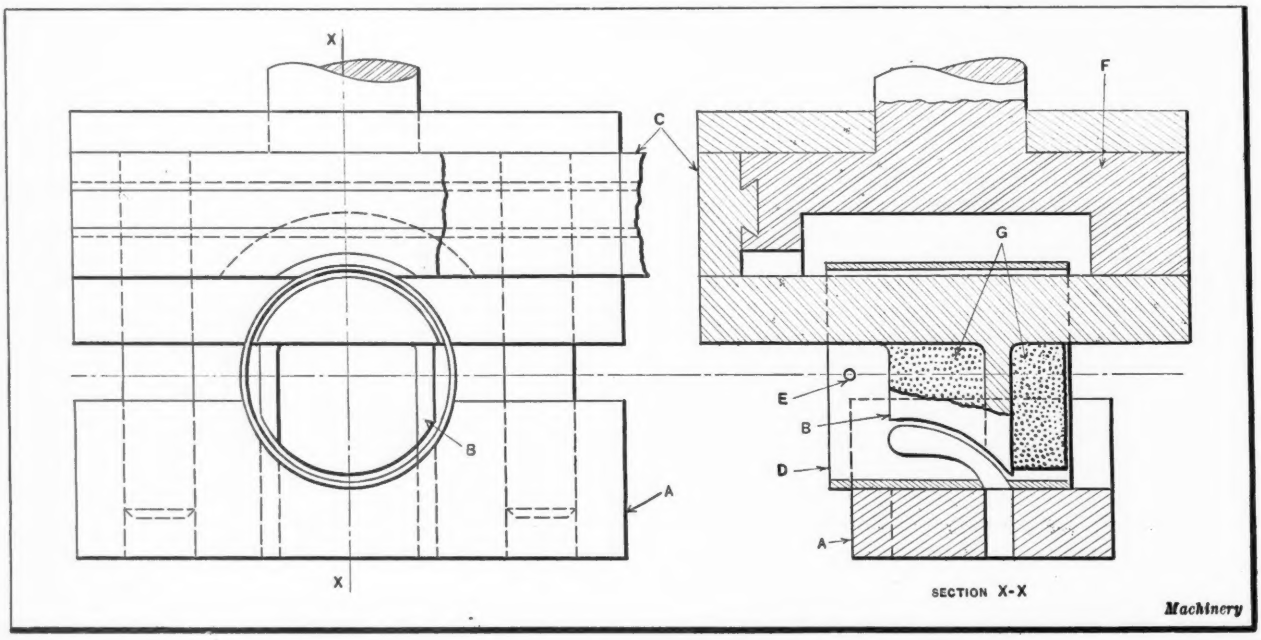


Fig. 2. Die for punching U-shaped Slot in Steel Tube

Dies and Fixtures for Display Hooks

By DONALD A. BAKER

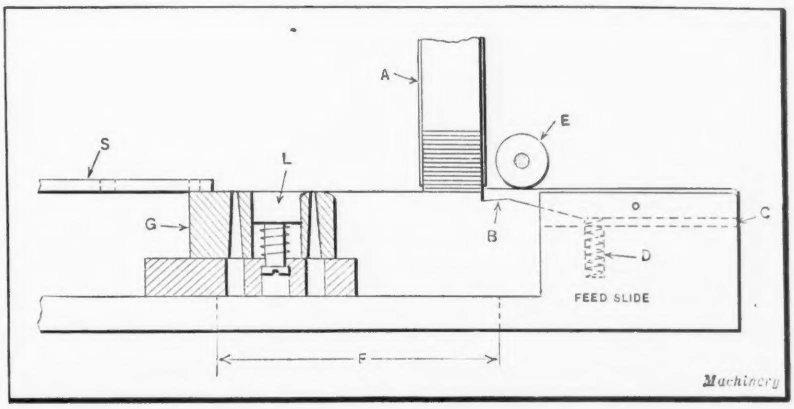


Fig. 1. Hopper-fed Piercing and Bending Die for Hook Bottoms

THE dies and fixtures described in this article are used in the factory of the McCorkle-Ensign Co., Elmira, N. Y., in the manufacture of display hooks like the one shown in Fig. 2. These hooks consist of two formed pieces of sheet metal *A* and *B*, a spring *C*, and a hinge pin *D*. The sheet metal pieces are made from stock purchased in rolls. In making the top member *A*, the stock is fed directly into a double-acting cut-and-carry press, as shown in Fig. 5. The part is blanked by the punch *Y*, being forced down through the die *A* into a slide *B*. This slide has two cam rollers *C* and *D* which are in contact with the cam *E*. The cam *E* imparts a reciprocating motion to slide *B* which carries the blank from the blanking die to the left until it is directly under the piercing and bending slides *F* and *G*. These slides are cam- and crank-operated in the conventional manner.

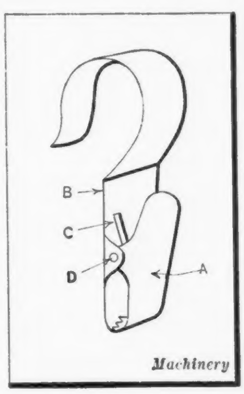


Fig. 2. Display Hook

After the blank is brought under the piercing and bending slides, two punches, one of which is shown at *H*, descend and pierce the two pin holes for the hinge pin. As soon as the piercing operation is completed, the bending punch in slide *G* aided by two side strippers, one of which is shown in the plan view at *J*, strip the work from the piercing punches as the latter move upward. The continued downward movement of the bending punch forms the blank to the required shape and carries it down through the die, from which it drops into a pan and is ready to go to the bench where the workman assembles the various parts of the hook preparatory to riveting.

Method of Making Bottom of Hook

The bottoms *B*, Fig. 2, of the hooks are first blanked from the coiled stock, after which they are transferred to a special hopper-fed piercing and bending press. Before placing the blanks in the hopper, they are run through a pair of power-driven rolls which take out any slight kinks and flatten down any burrs that may have been left on the edges of the pieces. As the blanks leave the rolls, they fall into a small stack which is transferred to a rack at the front of the machine. From the rack the blanks are placed in the hopper of the piercing and bending press by the operator.

The construction of the hopper-fed die is shown diagrammatically in Fig. 1. In Fig. 3 is shown a cross-section of the piercing and bending portion of this die. The body *G* of the die is slightly rounded at *R* so that on the down stroke of the ram the toothed end of the clip will be bent up around the end of the punch *N*. The opposite end of the piece is bent over the half-rounded section of the mandrel *H* which has a reciprocating movement in the hole *J*. The final bend is produced by the swinging arm *E* which is operated by a cam on an overhead shaft that is part of the machine.

At *L* is shown a spring pad for ejecting the work from the die after it has been pierced and bent. The stripper *S* is also of the reciprocating type and serves to strip the work from punch *M*. Bending punch *N* and the holder for the piercing punch *M* are carried on independent slides, one being operated by the press crank and the other by a cam, driven by the crankshaft. The slide *P* pushes the finished piece from the top of the die. This slide is operated by a cam-actuated lever *K*. When the press is in operation, the blanks, which have been rolled to remove the burrs as previously described, are placed in the hopper *A*, Fig. 1, from which they are fed to the top of the die by means of two fingers, one of which is shown at *B*. These feeding fingers are held against feed-rolls *E* by coil springs *D*.

The position of the feed-rolls can be adjusted to control the height to which the fingers rise. When the rolls are properly adjusted, the ends of the fingers can only rise to sufficient height to remove one blank from the hopper at each stroke. After passing beyond the hopper, the feeding fingers continue to rise so that they pass over the top of the die for a short distance, carrying the blank into the required position on the piercing and bending die *G*. The fingers are positively prevented from rising too high by coming in contact with the bottom of the slot shown at *C*, which is cut in the feed slide. It will be noted that there is a slot of width *F* through the feed slide which permits the punchings to fall through the die. The die is shown at *G* and the shedder at *L*, while the cam-operated stripper is shown at *S*. All the various movements of the die members and the feed mechanism are controlled by cams on the overhead camshaft.

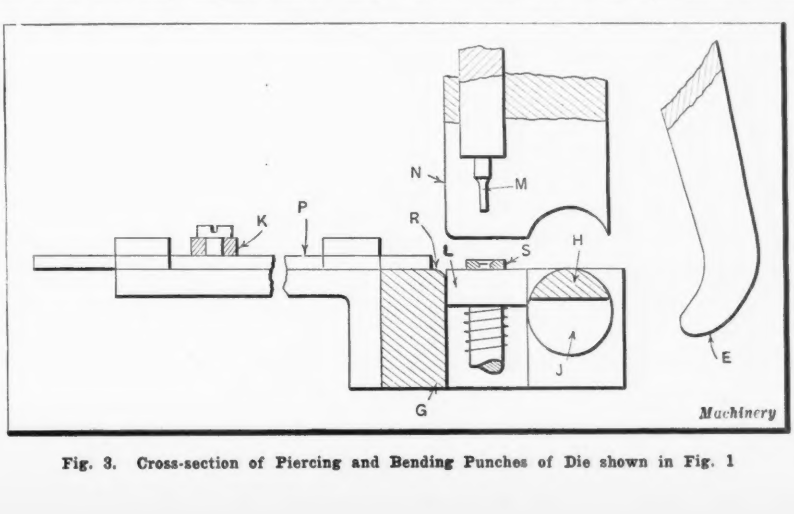


Fig. 3. Cross-section of Piercing and Bending Punches of Die shown in Fig. 1

Assembling the Hooks

After the various parts of the hooks are completed, they go to the assembling bench, where they are assembled by girls who employ a small hand-operated fixture like the one shown in Fig. 4. The bottom member *B* of a hook is first placed in the fixture as shown, and a spring *C* is next put in place and clamped in position by the jaws *E* of the fixture. The jaws are forced together by a simple movement of the lever *F* which rotates the cam *G*. The operator then places the top member of the hook in position with his left hand, while inserting the hinge pin with his right hand. The assembled hooks are taken to an automatic rivet-spinning machine having a rotating work-holding head.

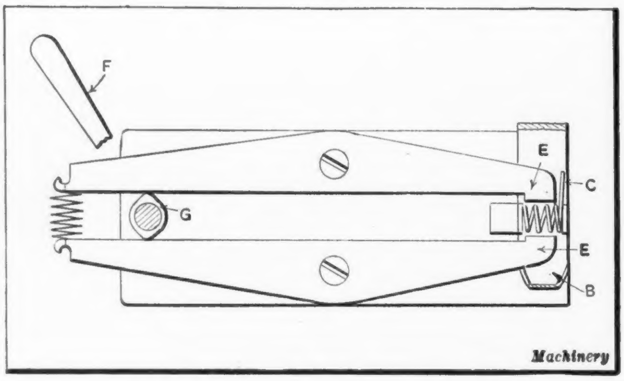


Fig. 4. Assembling Fixture for Display Hooks

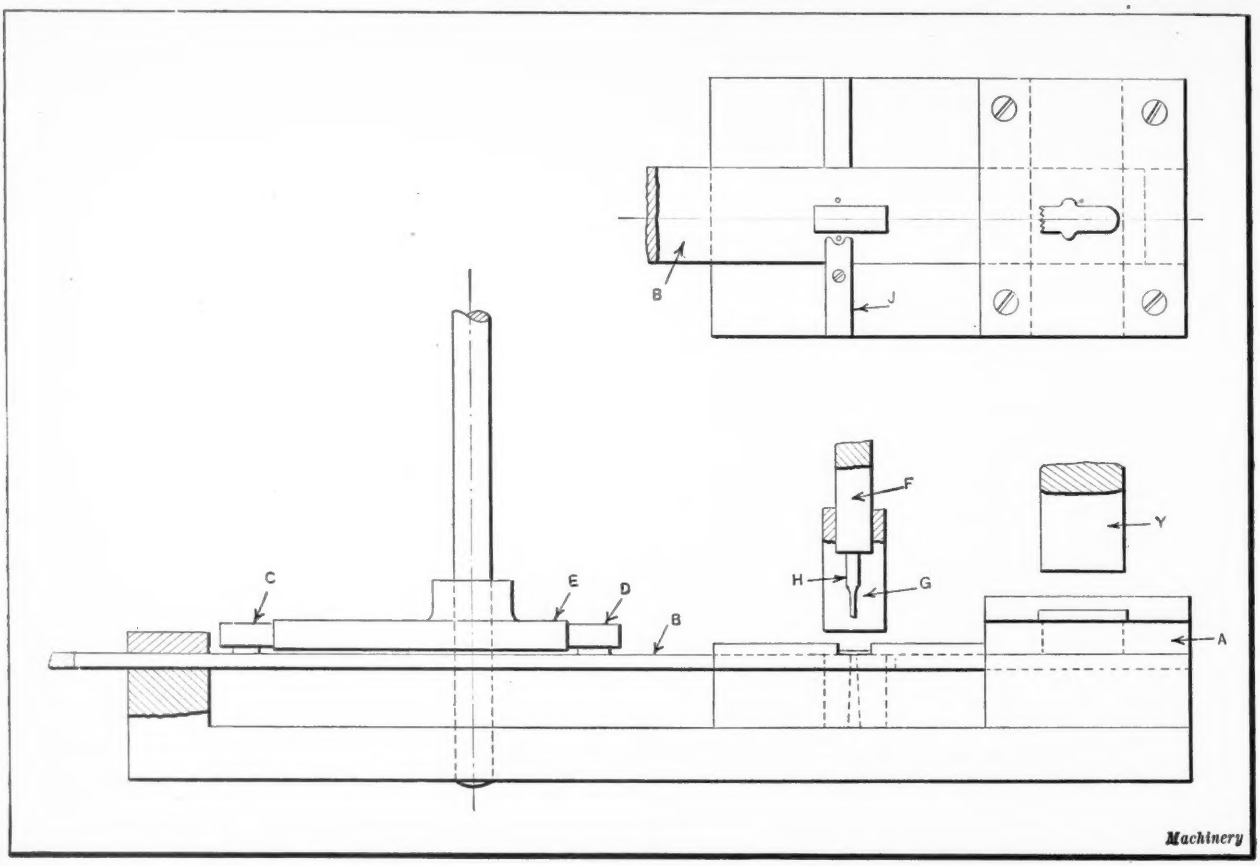


Fig. 5. Transfer Type of Die used to blank, pierce, and form Part A, Fig. 2

Operation of Riveting Machine

The assembled hooks are held on the periphery of the rotating head of the rivet-spinning machine in the manner illustrated in Fig. 6. There are twelve work-holding positions, and the head is indexed one space at a time by a cam mechanism. The speed of the indexing movements can be regulated to suit the operator, although it does not matter if the work-holding position is allowed to pass the operator without being filled. After being placed in the rotating head, the assembled part passes a bell-mouthed spindle which is pushed forward over the hinge pin so that the part is located in the correct position.

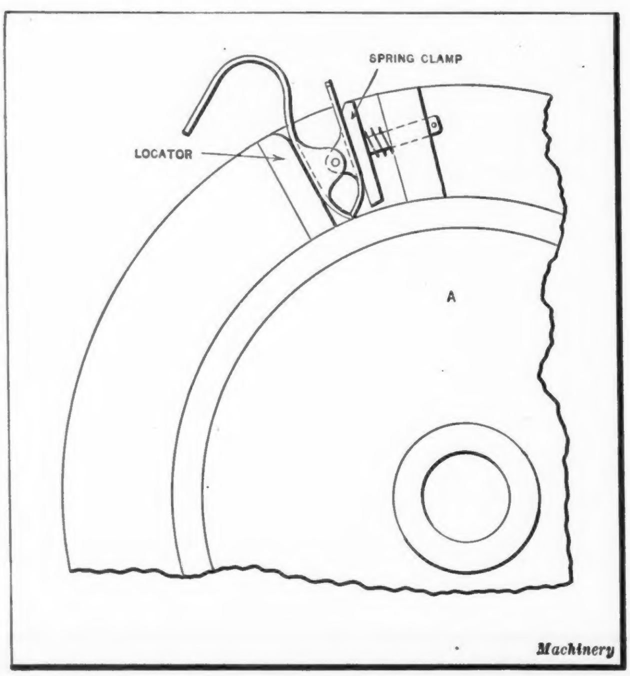


Fig. 6. Method of holding Assembled Hooks on Riveting Machine

In order to facilitate assembling, the hinge pins are made about 1/8 inch longer than would otherwise be necessary. This surplus length is cut off by two shear blades at another position on the machine. After being sheared off, the hinge pins are indexed to a position beneath the spinning head, which is moved forward by a cam. When the ends of the pins have been spun over, the assembled parts are ejected from the machine. The completed hooks are bright-dipped, tumbled, or given such finish as demanded.

* * *

Exports of industrial machinery from the United States to Spain were the same in 1924 as in 1923, but showed a material increase as compared with 1922. The total for 1922 was only $1,371,000, whereas the exports during the first nine months of 1924 rose to $1,487,000.

Letters on Practical Subjects

ADJUSTABLE GAGE FOR TESTING LOCATION OF HOLES

The gage shown in Fig. 2 was made for use in gaging the distance between the holes pierced in plates such as shown at *A*, *B*, and *C*, Fig. 1. These plates comprise one set or assembly, and the spacing of the holes in the three plates must be the same, although the holes are not alike. As these sets of plates are made in different lengths, each length having a different dimension between the holes, it was necessary to provide a means for adjusting the distance between the plugs *C* and *E*, Fig. 2. It will be noted that the holes measured are of different sizes, those in the upper piece being 1/4 inch in diameter, those in the middle piece 5/16 inch square, and those in the lower piece 3/8 inch in diameter.

The gage provides means for inspecting the center distances after the holes have been punched, thereby furnishing a check on the set-up of the sub-press dies which are adjustable as regards the center distance. The gage consists of a base *A* in which is machined a dovetail groove *B*. At *C* is permanently fixed a plug having three diameters at its upper end. The block *D* is adjustable in the dovetail groove *B*. On this block is a plug *E* having three diameters corresponding to the three diameters of plug *C*, and a spring pin *F* passing through its center. Spring *G* normally forces pin *F* downward so that the large diameter *H* on the pin enters a hole in the body of the gage. This permits setting the gage at various center distances, as shown by the indicating lines and figures from 1 to 12, at which points holes to receive the spring pin are located. With the pins set the required distance apart, the holes in the various plates must pass over the size on the pins corresponding to the size hole in the plate, in order to pass the inspection test.

Another feature of the gage is the block *J* which is adjustable in the dovetail slot. This block, in combination with a scale *K*, indicates the distance from the hole to the

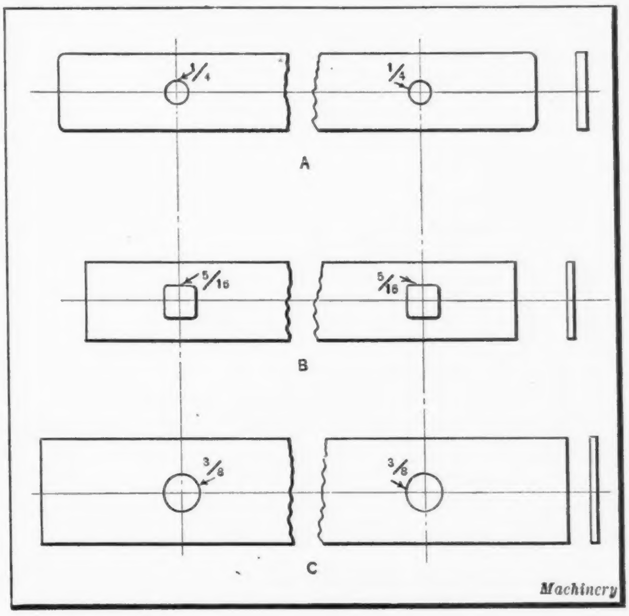


Fig. 1. Set of Three Plates that require Accurate Piercing

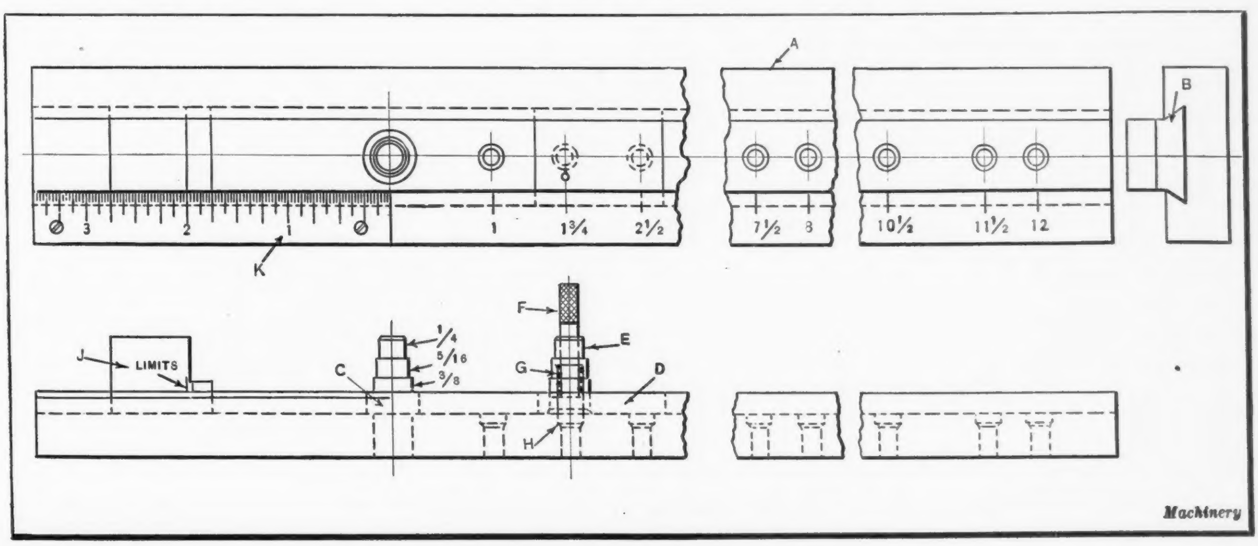


Fig. 2. Gage for testing Spacing of Pierced Holes

end of the work. Two lines, as designated by the word "limits" on the block *J*, in conjunction with the lines on the scale, enable the user of the gage to tell whether the holes are being punched the correct distance from the end. It will be noticed that round portions on the plugs are used to gage the square hole in plate *B*, Fig. 1, and that the arrangement of adjustable pins provides for no plus or minus center limits. Where plus or minus limits are required on the holes, additional steps can be provided on the plug. The 1/4-inch holes in plate *A* should then go over the small diameters measuring a few thousandths under 1/4 inch but not over those measuring more than 1/4 inch. The other plates would be tested on the 5/16- and 3/8-inch diameter plus and minus sizes.

This type of gage is not intended for measuring to extreme degrees of accuracy, but it is one of that class of specially designed tools which can be used extensively for testing within commercial limits. For extreme accuracy there should not, of course, be any sliding members in a gage.

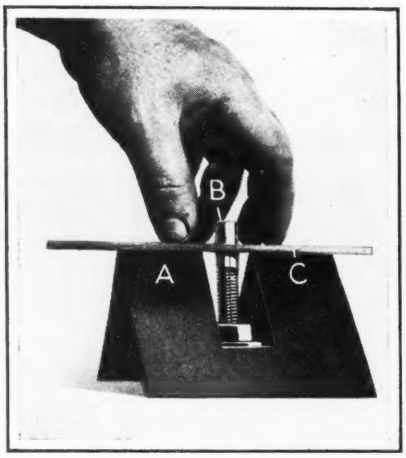
Holyoke, Mass. F. H. MAYOH

CIRCLE LAYING-OUT DEVICE

Circles scribed with dividers and other similar fine-pointed tools are not always easily seen, and for rough work too much time is generally spent in using such instruments. This was the condition encountered in scribing circles on square pieces of sheet metal from which disks were to be cut. The simple circle marking device shown in the accompanying illustration overcame these difficulties, however, and has proved very satisfactory.

A large quantity of sheet-metal disks with a ½-inch hole in the center was required. The procedure in making these disks was to cut the sheet metal into squares and then clip off the counters of the square sheets to conform roughly to the finished diameter. Finally a dozen of these roughly trimmed pieces were placed on an arbor in a lathe and turned to the required diameter. The circle laying-out device is used after the holes have been drilled in the center of the square pieces.

Referring to the illustration, the body *A* of the device is a piece of sheet metal bent to a V-shape. Two slots were sawed down in the center of the V-shaped piece about an inch apart, after which the top of the center piece was filed off to permit both sides to be bent down or folded one over the other. A hole was drilled through the folded pieces and a ½-inch headless screw *B* clamped in the position shown, by two nuts. The length of the V- or wedge-shaped edge of the device is made equal to the diameter of the disks to be made. A square metal piece that is to be made into a disk is roughly chalked on one side, after which the piece is placed on the device in the position shown at *C*. By revolving the disk with the finger tips as indicated in the illustration, the chalk will be scraped from the disk, leaving an outline which can be easily seen by the workman.



Convenient Circle Laying-out Device

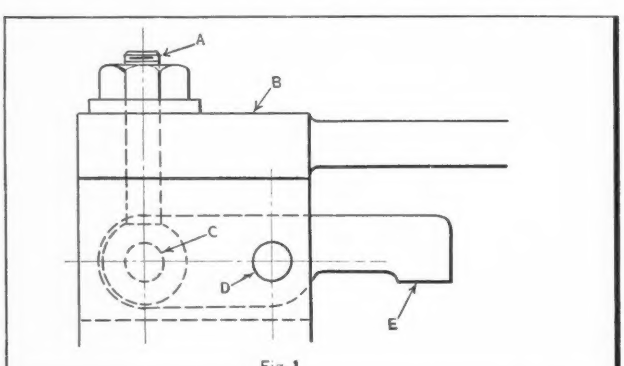
Rosemount, Montreal, Canada HARRY MOORE

CLAMPING DEVICES FOR JIGS AND FIXTURES

Two clamping operations are generally required to secure a piece of work in a box jig. However, by designing the work-holding device as shown in Fig. 1, the clamping can be accomplished in one operation. The jig has the usual cover *B* and eyebolt *A*, but instead of being pivoted in the jig body the eyebolt is pivoted on pin *C* at the end of clamp *E*, which is mounted on the fulcrum stud *D*. It is evident that tightening the eyebolt nut serves to bind both the cover and the work in place.

Milling fixture specifications often call for some type of centralizing clamp, and the usual arrangement is to have one fixed stop and one adjustable screw, but this principle does not always compensate for variation in the size of the castings. In Fig. 2 is shown an arrangement that provides for variation in the work. The hexagon-head screw *D* is drilled and tapped to receive the screw *C*. Screw *C* also has a keyway that is a sliding fit for the key *B* which is retained in the bushing *A*. As the lead of screw *C* is twice that of screw *D*, one turn on the hexagonal head of screw *D* causes each screw to be moved outward or inward an equal amount.

Fig. 3 illustrates an idea that was incorporated in a jig for holding a piece having two lugs to be drilled. One of



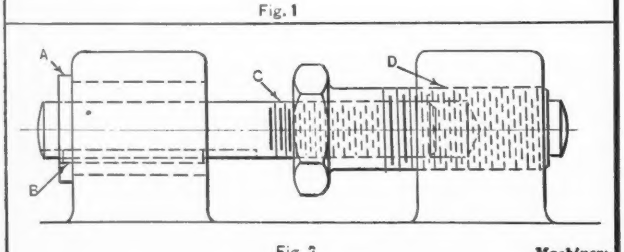


Fig. 1. Clamp for Box Jig Fig. 2. Centralizing Clamping Screw

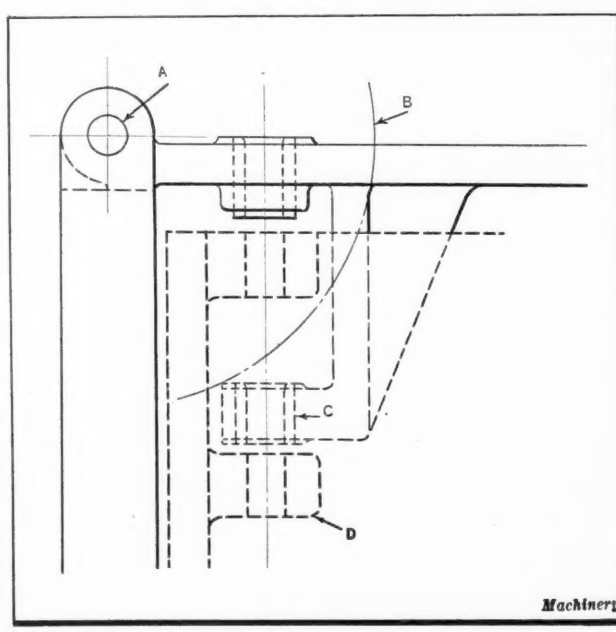


Fig. 3. Drill Jig Cover with Special Bushing Arrangement

the lugs *D* is a few inches inside the casting, and could only be drilled from one side. A guide bushing was therefore required to guide the drill for the second hole. The bushing *C* is pressed into a projection on the cover, and when the cover is opened for reloading the jig, the bushing boss and bushing *C* swing out on the arc *B* about the pivot pin *A*.

Figs. 4 and 5 show good methods of providing locating stops when it is difficult or impossible to have machined pads or projections on the inside of the jig The locating dimensions for the holes to be drilled are taken from the outside of the fixture. Thus *B* minus *A* would be the actual dimension from the end of the stop to the hole.

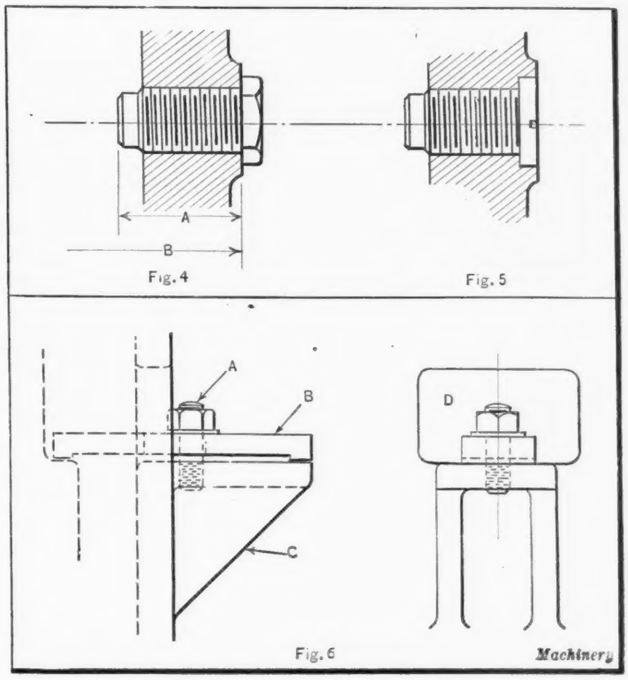


Fig. 4. Locating Stop Fig. 5. Stop with Flush Type of Head
Fig. 6. Clamp that extends through Wall of Jig

In laying out a jig for a large piece of work, it was found impossible to get at the clamping point from the inside. This problem was solved, however, by the construction shown in Fig. 6. A hole *D* was cored in the wall of the jig and a projecting shelf *C* provided at the lower edge of the cored hole. The stud *A* passes through an elongated slot in the clamp *B*, permitting the clamp to be drawn back so that it will clear the work.

Fitchburg, Mass. E. E. Lakso

ADJUSTABLE DRILL JIG

A drill jig with some unusual features is shown in the accompanying illustration. The part indicated by the heavy dot-and-dash lines at *A* is required to have two holes drilled in it, one at each end. These parts are made in various lengths, but each part is required to have the holes located the same distance from the ends, and for this reason the unit that holds bushing *B* is made adjustable so that one jig can be used for the different lengths. The jig bushing leaf *D* is permanently attached to the base *H* of the fixture by a block *J*. Bushings *B* and *C* are held in the swinging plates *E* and *D* which are pivoted on hinge-rods *F*. These swinging plates permit the removal of the work, plate *D* being swung to the left and *E* to the right.

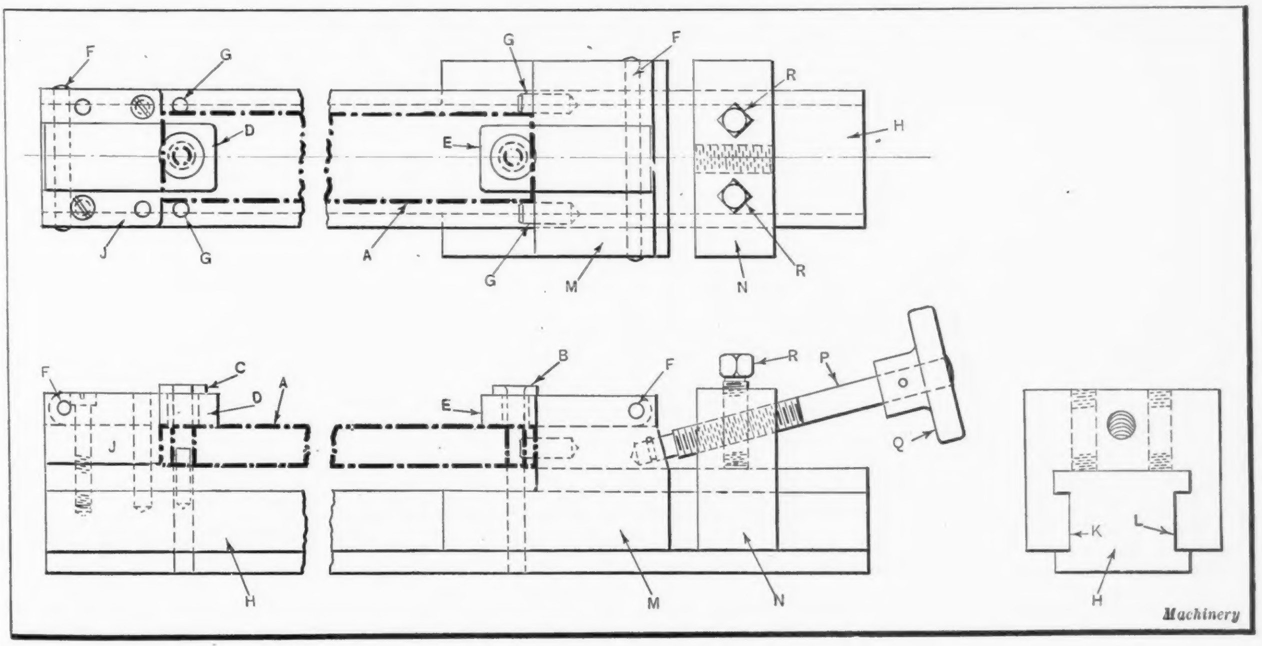
Four pins *G* locate the work sidewise. In the sides of base *H* are two grooves *K* and *L* which are clearly shown by the end view. The block *M* is free to slide on the base and is provided with side lips that fit into the grooves *K* and *L*. Block *N* also slides on base *H*. A screw *P* having a handwheel *Q* is fitted into a hole in block *N*. Two screws *R* clamp block *N* to the base *H*. The operation of tightening screw *P* serves to clamp the work in place through the medium of the sliding block *M*.

In using the jig, the operator merely loosens screw *P* slightly and throws open the swinging plates *D* and *E*. The drilled work is then removed and another part placed in position after which screw *P* is tightened and the plates *D* and *E* swung back into position. The drilling operation is then performed in the usual manner, the drills being guided by the bushings *B* and *C*. F. Server

STRAIGHT-SHANK ADAPTER SLEEVES FOR MORSE TAPERS

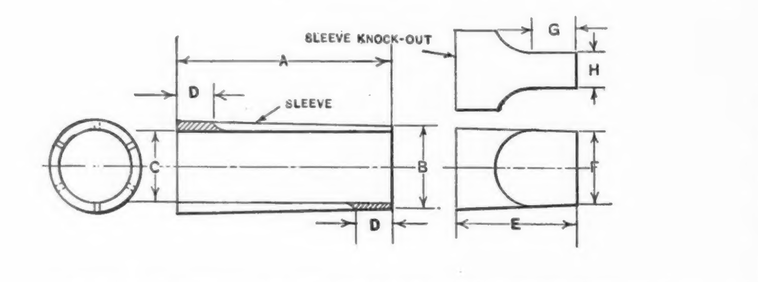
The accompanying table gives the dimensions for a set of adapter sleeves for holding straight-shank tools such as reamers, drills, turret lathe tools, and press tools in spindles having Morse taper sockets. A sleeve made as shown in the illustration at the head of the table was originally designed for holding a short combination reamer and facing tool in a universal head when milling and sharpening the flutes. This sleeve proved so useful that other sizes. as specified in the table, were developed.

The sleeves are made from machine steel and are not hardened. The knock-out also shown at the head of the



Adjustable Drill Jig for Parts of Varying Lengths

DIMENSIONS OF STRAIGHT-SHANK ADAPTER SLEEVES FOR MORSE TAPERS



Number of Taper	A	B	C	D	E	F	G	H
0	1½	0.336	⅛–¼	¼	25/32	0.240	9/32	5/32
1	1¾	0.403	¼–⅜	¼	13/16	0.356	3/8	13/64
2	2	0.609	⅜–½	¼	1	0.556	7/16	1/4
3	2½	0.822	½–¾	⅜	1 3/16	0.759	9/16	5/16
4	3	1.088	¾–1	½	1 11/16	0.997	5/8	15/32
5	4	1.551	1–1½	½	1 15/16	1.446	3/4	5/8
6	5½	2.240	1½–2⅛	½	2 13/16	2.077	1 1/8	3/4

Machinery

table is made from tool steel. This knock-out is placed in back of the sleeve when the sleeve is used in a spindle through which there is no hole that would permit the use of a knock-out rod. The turning and boring operations required in machining the sleeves present no difficulties. As the slots are required only to allow for the necessary expansion and contraction of the sleeve, extreme accuracy is not required either in the spacing or cutting operation. The width of the slots may be from 0.025 to 0.035 inch, depending on the thickness of the slotting cutter available.

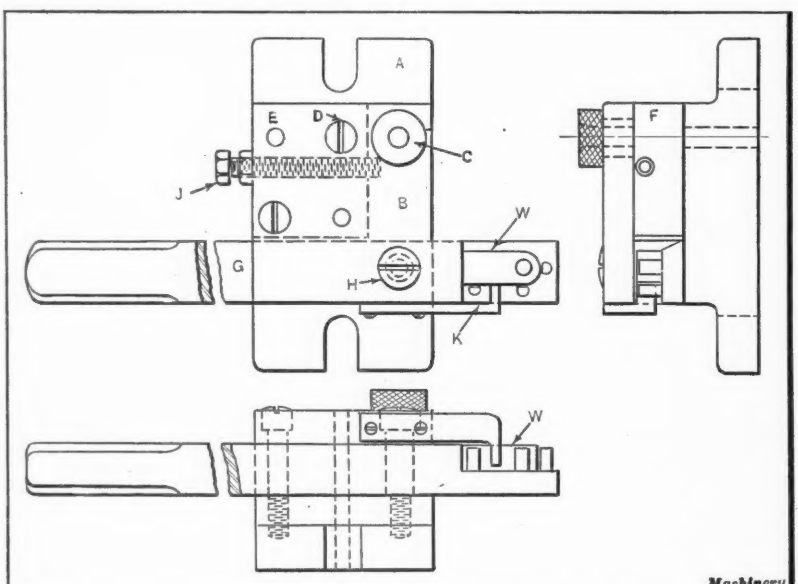
Hartford, Conn. F. MARTINDELL

QUICK-OPERATING DRILL JIG

The drill jig shown in the illustration herewith is simple in construction, and can be rapidly loaded and unloaded. The body of the jig *A* is bolted to the drill press table, being located by the drill and bushing. The plate *B*, in which the bushing *C* is secured, is fastened to the base by the screws and dowels *D* and *E* which pass through the spacing piece *F*. A nest for locating the work is made in one end of the swinging lever *G*. This lever pivots on the screw *H* to bring the work *W* directly under bushing *C*.

The adjustable screw *J* acts as a stop to locate the work centrally, and it is between this screw and the locating pins of the nest that the work is held while it is being drilled. The ejector *K* is fastened to plate *B* by screws as shown. The work is placed in the nest, and the lever is swung so that the work is brought up against screw *J*, where it is held while being drilled. After the work is drilled and the drill raised, the nest is swung out so that the work comes in contact with the ejector which discharges it from the jig.

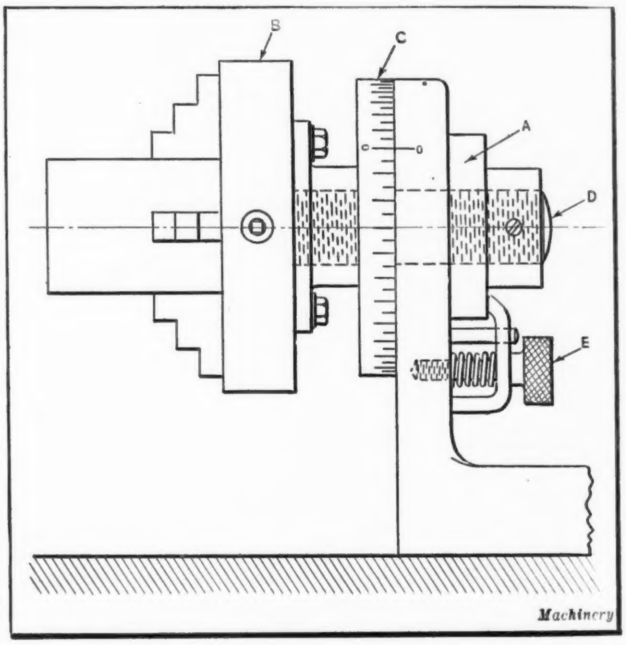
Brooklyn, N. Y. S. A. McDONALD



Drill Jig equipped with Work Ejector

DIRECT INDEXING FIXTURE

The fact that the simplest device may prove the most satisfactory is often overlooked in designing jigs and fixtures. However, this was not the case with the indexing fixture shown in the accompanying illustration. This fixture was designed to meet the need for a rapid and direct method of indexing in degrees, and is sufficiently accurate to meet the requirements of the work for which it was made. A regular indexing head could, of course, have been employed, but it would not have been nearly so convenient to use as the device described.



Fixture for Direct and Rapid Indexing

The various parts of the fixture were made up from scrap material which was picked up here and there around the shop, the chuck *B* being the only part that had to be obtained from an outside company. The washer *A*, chuck *B*, and graduated disk *C* are all connected by a stud *D*. The knurled-head screw *E* provides a means for locking the fixture after each indexing movement of the chuck, when necessary. The disk *C* is graduated for a movement of 360 degrees, the space between the graduations being large enough to permit estimating quite accurately a movement of one-fourth of a degree.

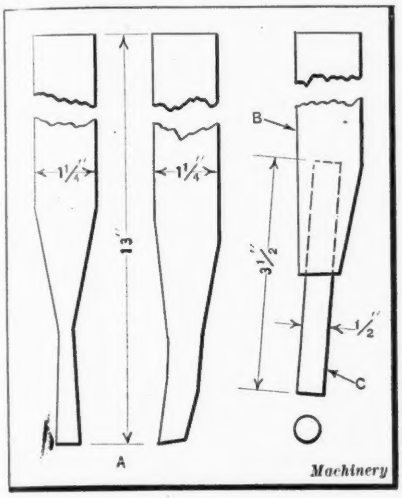
Philadelphia, Pa. HUGO LJUNGQUIST

Shop and Drafting-room Kinks

SAVING HIGH-SPEED STEEL

A tool department recently received a rush order for six high-speed steel tools like the one illustrated at *A*. As enough high-speed steel of the size required could not be found in the stock-room, carbon tool steel was used for the shanks and hardened high-speed steel drill rod for the cutting ends. The carbon-steel shanks were made as shown at *B*, being drilled with an under-size ½-inch drill to receive a piece of hardened high-speed steel drill rod *C*. After being pressed into the shank of the holder, the piece *C* was ground to the required shape. This method of making the tool eliminated the necessity for using a large amount of expensive high-speed steel, and the results obtained were satisfactory.

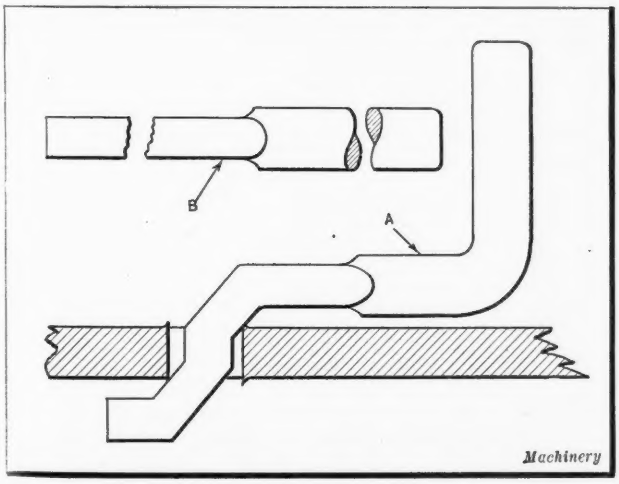
F. RATTEK



Solid and Inserted-point High-speed Steel Tools

REMOVING BURRS FROM DRILLED HOLES

In drilling holes through steel, particularly soft steel plate, the drill raises burrs where it breaks through the steel, and also raises an edge where it enters the metal.



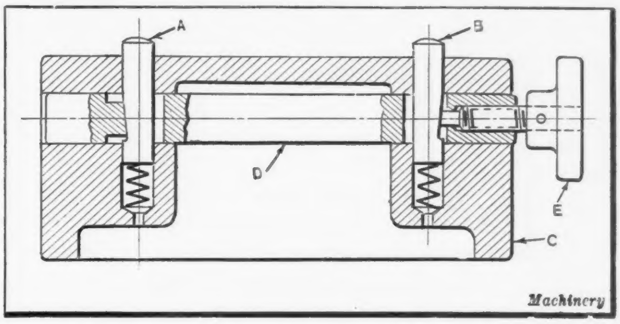
Hand Tools for removing Burrs from Holes drilled in Steel Plate

The burrs and raised edges interfere with the insertion of bolts and rivets, and for this reason it is the general practice to remove the interfering metal with a large drill or countersinking reamer. This operation can be performed quickly and satisfactorily with a simple hand-operated tool like the one shown at *A* in the accompanying illustration. The complete operation of removing the burrs and raised metal from a drilled hole can be accomplished with this tool from one side of the plate. The tool is made from a piece of drill rod ground to a rectangular shape as indicated at *B*, which is bent to the form shown at *A*. The bent-up end, which is left round, serves as a handle by which the operator can give the tool the number of turns required to remove the burrs and raised edge.

Washington, D. C. GEORGE A. LUERS

CLAMPING DEVICE FOR SPRING PLUNGERS

The method of clamping spring plungers shown in the accompanying illustration can be used to advantage for jigs or fixtures having two plungers. The plungers *A* and *B* are a slip fit in the casting *C*. These plungers pass through elongated holes in the bar *D*. The left-hand end of the slot for plunger *A* is beveled at an angle of 7 degrees to correspond with the angular surface machined on the side of



Method of clamping Spring Plungers

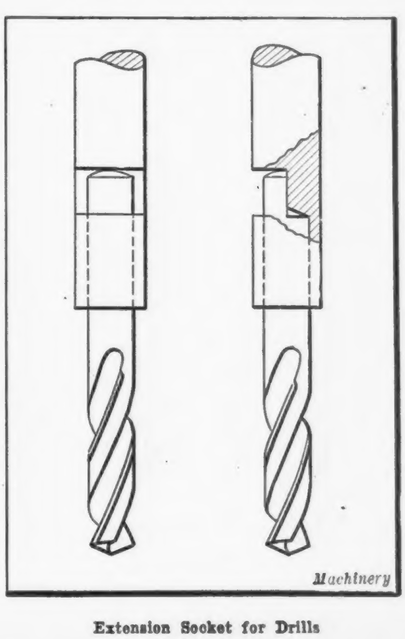
the pin. When the knob *E* is tightened, plunger *B* is clamped in place, and at the same time bar *D* is drawn to the right, thus clamping the pin *A* in place.

Woonsocket, R. I. N. E. BROWN

EXTENSION SOCKET FOR STRAIGHT-SHANK DRILLS

The simplest extension socket for a straight-shank drill, and probably the most satisfactory type, is one made from a piece of drill rod of the required length and of a diameter which is large enough to support the drill after being bored to receive the shank. The hole bored for the shank of the drill should be at least twice as deep as the diameter of the drill. The depth of the slot milled in the extension rod at the end of the hole should be equal to one-half the diameter of the rod. A step should be cut at the end of the drill shank, as indicated in the illustration. This step engages the bottom of the slot milled in the extension rod in a clutch-like manner. It is necessary that the drill and the socket should be carefully fitted so that the drill, when tapped or pressed into the socket, will be firmly held in place.

JOHN MCNEISH
Boston, Mass.



Extension Socket for Drills

Questions and Answers

STANDARD NUMBER OF THREADS

M. I. S.—Kindly state the correct number of threads per inch on 1 1/16 U. S. standard taps, and also on 1 1/16 S. A. E. standard taps.

A.—According to the formula adopted at the time that the Sellers thread was accepted as the standard thread of the United States Navy in 1868, and as contained in the "Report of the Board to Recommend a Standard Gage for Bolts, Nuts, and Screw Threads for the United States Navy," made in May, 1868, the 1 1/16 size in the U. S. standard thread system has 7 threads per inch. A table based upon this formula will be found on page 168 of "Standards of Length and Their Practical Application," published in 1887 by the Pratt & Whitney Co., Hartford, Conn. The tables found in various handbooks (see MACHINERY'S HANDBOOK, Sixth Revised Edition, page 1149) also give this information.

In the present standard of U. S. threads known as the American (National) Standard of coarse screw threads, the 1 1/16 size is left out, and is no longer to be considered standard.

There is no 1 1/16 inch size in the S. A. E. Standard. The 1 inch size has 14 threads, and the 1 1/8 size has 12 threads.

ARC SINE AND ARC TANGENT

E. C. L.—In looking over some formulas involved in the solution of a tool-room problem, I came across the expression "$\sin^{-1} a$." While I only have a limited knowledge of trigonometry, it was evident from the nature of the problem that this expression was intended to represent the arc or angle corresponding to the sine of angle a. Is this expression commonly used in advanced trigonometrical work, and is the same expression used in the case of other trigonometrical functions, such as cosine and tangent?

A.—The expression "$\sin^{-1} a$" is read "arc sine alpha," and your understanding of its meaning is correct. The expressions "arc sine," "arc tangent," "arc cosine" and "arc cotangent," or, as used in their abbreviated forms, "arc sin," "arc tan," "arc cos," and "arc cot," are used frequently in trigonometrical work to signify an arc or angle that corresponds to a given value of cosine, cotangent, etc. For example, the sine of 40 degrees is 0.6428; then arc sin 0.6428 = 40 degrees. While the expression "arc sin a" is frequently written in the form "$\sin^{-1} a$" the latter expression can hardly be considered as being in keeping with good mathematical practice, because the use of a negative exponent in this manner might easily lead to confusion and be misunderstood for the expression $(\sin a)^{-1}$ which means the reciprocal of sin a, or $1 \div \sin a$.

CALCULATING DIAMETER OF GAGE-CHECKING DISK

L. R. M.—In making a gage such as shown at *A* in the accompanying illustration, it was found desirable to check the accuracy of the work by using a disk *B* in the manner indicated. The 0.313 inch radius is required to be 0.126 inch deep on one side. The problem is to find the radius x of a disk *B* which will be tangent to the base line, the center line *SP*, and the radius. Will some reader of MACHINERY please show how the diameter of disk *B* can be calculated?

ANSWERED BY J. A. PORATH, SOUTH BEND, IND.

The radius x of the disk *B* may be found by solving the triangle *OPS*. By construction we have $OP = x$. Now the hypotenuse $OS = 0.313 - x$, the base $= x$, and the altitude $0.187 + x$. Therefore, in triangle *OPS* we have:

$$(0.313 - x)^2 = x^2 + (0.187 + x)^2$$

or

$$x^2 = (0.313 - x)^2 - (0.187 + x)^2$$

Expanding,

$$x^2 = 0.097969 - 2 \times 0.313x + x^2 - (0.034969 + 2 \times 0.187x + x^2) = 0.0630 - 1.000x$$

or

$$x^2 + 1.000x - 0.0630 = 0$$

Solving this equation by the quadratic equation:

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

we have by substitution,

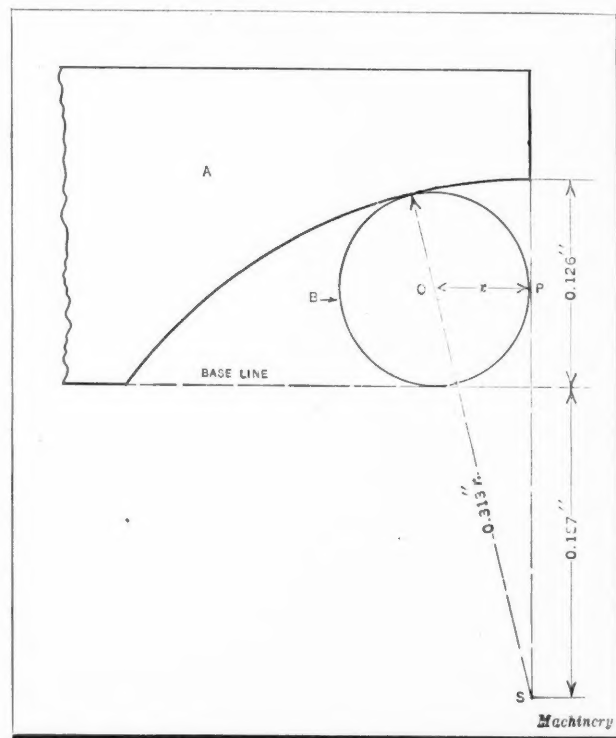


Diagram used in calculating Diameter of Disk

$$x = \frac{-1.000 \pm \sqrt{1.000 - 4 \times (-0.0630)}}{2}$$

$$= \frac{-1.000 \pm 1.1189}{2}$$

Disregarding the negative value of 1.1189 we have,

$$x = \frac{0.1189}{2} = 0.05945$$

and the diameter of disk $B = 2 \times 0.05945 = 0.1189$ inch

BASIC DIMENSIONS

D. E. M.—In dimensioning holes, and shafts or plugs which are to fit into them, is the standard nominal diameter usually applied to the hole or to the shaft?

A.—The nominal standard size from which variations are made to provide a certain class of fit, is generally applied to the hole, the shaft or plug being varied to obtain the kind of fit desired. The use of the hole diameter as the basic dimension has practical advantages in connection with securing different classes of fits. For example, assume that

holes are to be finished by reaming, and that shafts or plugs are to be fitted into them, this being a common condition in connection with various machine-building operations. If the diameter of the hole is basic, its size, within a small tolerance, may be maintained readily by the use of proper reaming equipment. On the other hand, the diameter of a shaft or plug may be varied much more readily than that of the hole, in order to obtain the allowance for whatever class of fit is desired; therefore, different kinds of fits in holes finished by the same reamer may be obtained merely by grinding the shaft or plug to a diameter which provides the proper fit allowance. In the case of threaded holes, the tap is usually solid or non-adjustable, whereas dies ordinarily may be adjusted readily to obtain different classes of fits.

As both the hole and shaft or plug would ordinarily be given a certain tolerance, the basic dimension of a hole (except for forced fits) should be the minimum limit or diameter, there being a plus tolerance, and the nominal dimension of a shaft or plug should represent the maximum limit or diameter, there being a minus tolerance. The advantage of this method is that the minimum clearance between hole and shaft, or the "danger zone," is indicated by a direct comparison of the basic hole diameter and the nominal shaft diameter; the direction of the tolerances is such as to increase this clearance. For a forced fit, the basic hole size is the maximum diameter, the tolerance being minus, and the nominal shaft size is the minimum diameter, the tolerance being plus; consequently, the minimum fit allowance or interference between hole and shaft (or the "danger zone" for a forced fit) is indicated by a comparison of the basic hole diameter and the nominal shaft diameter. In this case the direction of the tolerances increases the interference or forced fit allowance.

LOCAL HARDENING

L. R. C.—In casehardening crankshafts for a special machine by the carburizing process, it is desirable that certain portions of the shaft be left soft. How can this be effectively accomplished?

A.—The method of packing the work in the carburizing box so that the parts to be left soft will be unaffected by the carburizing material depends largely on the position and extent of the surface that is not to be hardened. If only a short portion of the shaft is required to be soft, a sleeve or collar may be used to prevent carburization. The sleeve or collar should be a close fit and should be made about ½ inch longer than the part to be left soft in order to prevent carburization near the ends of the collar.

When a considerable portion of the work is to be left soft, or the work is of such shape that a collar cannot be employed, the copper-plating method may be used. In this case, the article should be painted with enamel where it is to be hardened, the enamel being baked after being applied, while the remainder of the piece is copper-plated. The enamel will burn away and allow the surface covered by it to absorb carbon and hence to be hardened, whereas the copper will stand a very high heat, and having no affinity for carbon, will prevent its passage into the steel. The plating must be properly done in order to prevent the plate from chipping off under the effect of the carburizing heat. Some compounds that are rich in cyanogen also attack the copper and render it ineffective. This is especially pronounced as the temperature approaches the melting point of copper, which is 1981 degrees F. It is also obvious that the heat must be kept well below this temperature in order to avoid the danger of the copper running on the article. In general, if the copper-plating is burned off, it indicates that the heat has been too high.

Experiments have shown that a layer of electrolytically deposited copper from 0.001 to 0.002 inch thick is the most suitable coating agent for protecting portions of steel from carburization. Nickel cannot be used in place of copper, as it is permeable to carbon-monoxide. The copper is deposited on the parts to be casehardened by regular electroplating methods. Instead of using enamel on the parts to be hardened, the whole article may be copper-plated and the plate then removed from the parts that are to be hardened by machining. In some cases, the most satisfactory method is to leave extra metal on the parts that are to be left soft. After carburizing the part all over, it is allowed to cool in the carburizing box. The excess metal is then machined off, thus removing the casing at the desired points. After this operation, the article is heat-treated.

MEANING OF THE TERM "QUILL"

F. D.—A question has arisen regarding the meaning of the term "quill." The dictionary applies the term to a hollow shaft. If this application is made to machine shop work, it would seem to indicate that a bushing of a certain length might be a quill. With this understanding, is there a distinction between the application of the terms "bushing" and "quill," and is such a distinction due to the length of a quill or bushing? If it is due to the length will you kindly tell me at what length bushings end and quills begin? Also what is the difference between the application of the terms "bushing," "quill," and "sleeve." A specific application of the term "quill" is made to the back-gears of the lathe. Does the quill in this connection refer to the hollow shaft upon which the gears are mounted or does it refer to the two gears?

A.—The term "quill," in general usage, is applied to various kinds of hollow tubes, reeds, pipes, and hollow shafts or spindles. In mechanical work, the term "quill" is sometimes applied to hollow spindles, shafts, tubes, etc., as well as to certain special devices that in some way are related to or connected with hollow members. For example, "quill punches" are made of drill rod and are so named because they are supported (except at the projecting or working end) within a quill or hollow punch-holder, which, in turn, is held in the punch plate.

The quill of a bench lathe is an auxiliary spindle that is used for holding and revolving parts requiring extreme accuracy in the location of holes, etc. The spindle revolves in a bearing or "quill rest," which is placed on the bench lathe bed in front of the headstock. The work may either be held in a "chuck quill" (which is practically a hollow spindle), or attached to a "faceplate quill." The back-gears of an engine lathe are sometimes called quill gears because they are supported by a "quill shaft" or hollow shaft.

It must not be inferred that it is proper to designate all hollow tubes, pipes, and shafts as quills. Perhaps this may seem logical, but in the use of the various terms that are applied in mechanical work, it is necessary to be governed by prevalent usage; hence some hollow members are called quills, others sleeves, and still others bushings.

A bushing, according to the most common application of the term, is a removable lining that is usually placed in a hole to serve as a bearing surface for a spindle, or other part, and provide ready means for renewal, if necessary, on account of wear. The term "sleeve" is usually applied to hollow members which are longer than ordinary bushings; moreover, "sleeves," as the term is generally applied, are not used merely as linings for holes, but for various other purposes requiring a hollow part, as, for example, when a sleeve is fitted over a shaft or some other internal member.

A sleeve and a quill might be practically the same in form, and yet, under certain conditions, it would be correct to call one part a sleeve and the other a quill, assuming that they were used for different purposes and the names as applied agreed with common usage. It is impracticable to attempt to draw definite dividing lines between the meanings of terms like "quill," "sleeve" and "bushing," because these and many other mechanical terms are, to a certain extent, used interchangably and also differently in different lines of manufacture. If a hollow tube of, say, a musical instrument, is called a quill by musical instrument manufacturers, and a hollow tube of some machine is called a sleeve by machinery manufacturers, then, quill is correct in the first instance and sleeve in the second, even though the parts are practically identical in form and size.

The Machine-building Industries

A SOMEWHAT unusual situation may be observed at the present time in the business world. The purchasing power of the majority of our population is high, there being comparatively little unemployment and wages being higher in comparison with the cost of commodities than at any time in the past. The volume of sales of consumer goods, according to official reports by the Federal Reserve Bank, is large; car loadings, while not indicative of present activity in industry, but rather a record of past performance, remain unusually high, showing that goods are moving from producer to consumer; farmers are in a more prosperous condition than for several years past, owing to present prices for farm products; and savings bank deposits are mounting rapidly. All this may be briefly summarized in the statement that the country as a whole is prosperous.

Yet, side by side with these favorable conditions, we find that, except for some branches of the iron and steel industry and some autotmobile plants, factories in most other fields require only part of their manufacturing facilities to meet the demand for goods. The reason for this is simple. Our industries have developed at a far more rapid pace than our consuming capacity, even when the latter is fully normal, and the total plant capacity in almost every field is greater than is required by any normal needs of the country. Hence, we have the paradoxical condition of a country in a general state of prosperity with many of its factories running at partial capacity only, and in many cases unable to obtain a fair return on the capital invested. That this condition can exist side by side with fair employment conditions indicates that if all our factories were running at full capacity, there would undoubtedly be a severe labor shortage. We are overexpanded as regards industrial manufacturing facilities, and apparently only time can correct this condition.

The foregoing statements relating to the general business situation are borne out by the reports of the Federal Reserve Bank to the effect that the general business situation continues to be satisfactory; production in the basic industries shows an increase; and the steel industry has been operating at almost full capacity.

General Conditions in the Machine Tool Industry

In the machine tool industry, a decided improvement was noticeable during the months of December and January, as recorded in this review last month. This improvement, however, did not generally continue during February, although, on the average, new business booked during this month equalled that of January. It is generally admitted that while the business in machine tools has not equalled the great volume anticipated, it has in almost every case been better than the average for 1924. There is a distinct tendency toward the buying of higher grade machines, and a willingness on the part of many purchasers to pay the higher prices necessary to do this. There is also a tendency toward buying new machines in cases where formerly efforts were made to obtain second-hand equipment.

A gratifying increase in foreign business is in evidence in several instances. What may be designated as the first order of any magnitude from Europe since 1920 has been placed by a large Italian automobile concern, and several machine tool builders have obtained considerable business from this source. Another unusual feature in the foreign market is the fact that several planers have lately been shipped abroad, some to Germany. A year ago it would hardly have been thought possible that this could be done, but the improved conditions abroad, especially in Germany, and the quality and high reputation of American machine tool equipment, have paved the way for these sales.

The Domestic Machine Tool Market

In the domestic market the number of inquiries indicates potential activity, but the cautious attitude of most manufacturers using machine tools delays considerably the step between inquiry and order. Prices in the machine tool field are generally low, compared with prices in other machine-building fields, producing on a similar basis—that is, a basis of comparatively small production. The railroads have not yet entered the market to any considerable extent, but the conditions are promising for a considerable amount of business from this source. In the Detroit district, the automobile industry did not enter the machine tool market as actively as was expected during January and February, but during March a fair number of orders were placed.

Referring specifically to different types of machine tools, it may be mentioned that the lathe, radial drill, and sensitive drill business has shown an improvement. There has been a fair demand for planers, while the shaper business is on about the same level as during the past year. The demand for centerless grinding machinery is constantly increasing. In the gear-cutting machinery field, the demand for several years has been proportionately greater than in other branches, and this demand continues.

The demand for second-hand machinery is normal, but several dealers state that the proportion of new machinery sold is greater, relative to used machinery, than during the past year. A number of machine tool builders believe that some system of designating the "obsolescence" of used machines ought to be employed and that such a system, which would indicate when a machine is to be considered of obsolete design, would be of benefit both to dealers in used machinery and to buyers, as it would indicate how far the present art in machine tool design has advanced since the building of the machine offered in the second-hand market was built. This would aid in placing a fair and accurate value upon the used machine.

In the electric tool business, sales have not been as good so far this year as they were during corresponding months last year and the export business has also fallen off. In this field prices are extremely low, and some manufacturers find it practically impossible to meet competition on the present price level, which they find to be below cost. Only in isolated instances have manufacturers in this field had what they would consider a satisfactory business during the last three months.

Small Tools and Accessories

The small tool business is fairly active, but orders are generally for small quantities, which means that production costs run higher. The twist drill business is on a more satisfactory basis than it has been for years, and the demand for wire-gage drill sizes is particularly good. The milling cutter business is also more active. Plants making large circular saws are well occupied, but the demand is for wood saws rather than for metal saws.

In the special tool and gage field business conditions fluctuate to even greater extremes than in the machine tool field, but on the whole the well-known shops in this branch of the industry are enjoying a better volume of business than during the last six months of the past year. The die business is especially good in many of the toolmaking centers, while the business in gages remains about the same as it has been in the past year.

The demand for machine shop clutches has improved, and several machine tool builders who have not ordered clutches for a long period have again come into the market. Of two leading clutch manufacturers, one states that "business is good," and another that it is "much better of late."

New Machinery and Tools

The Complete Monthly Record of New Metal-working Machinery

Cincinnati "Hypro" Planer

NEW and improved features are embodied in the "Hypro" planer recently brought out by the Cincinnati Planer Co., Cincinnati, Ohio. Convenient and foolproof operation and simplicity were the aims in designing this machine. Selective dial feeds are furnished for all heads; the dials are graduated in sixty-fourths of an inch, and so arranged that any feed up to 1 inch can be instantly set and the reading determined from the front of the machine. There are separate feeds for each of the rail and side-heads, and they are equipped with a safety device so that there will be no breakage of parts should they accidentally be fed into each other.

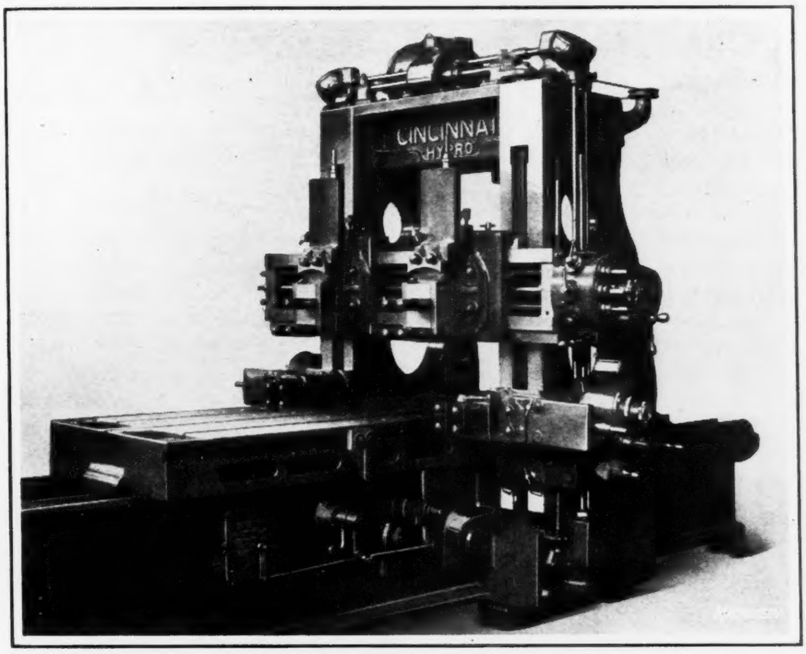


Fig. 1. Cincinnati "Hypro" Planer with New and Improved Features

The rail is clamped to the inside face of the housing by means of a device that is operated by giving a single turn to a crank-handle at the end of the cross-rail. This clamping mechanism automatically disengages a gear when the rail is clamped, so that it is impossible to use the elevating mechanism. When the rail is released, the elevating gear is automatically re-engaged. Automatic stops limit the rail travel. The rapid power traverse is so arranged that by operating one lever, either or both rail-heads can be moved across the rail and the tool-slides moved up or down at the same time. Any of these movements can also be secured independently and reversed through the operation of the same lever. A rapid traverse is provided for both side-heads independently of the rail-heads. A slip clutch prevents damage if the heads are run together or beyond their limits. All control levers for the rapid traverse, rail clamp, rail lift, and feed adjustment are so placed that the operator need not change his position to operate them.

The bed is double the length of the table so that the table never overhangs. Both the bed and table are of box construction, and ribbed lengthwise and crosswise. An inner guide is provided between the bed vees to absorb heavy side thrust obtained when taking deep cuts and thus prevent the table from lifting out of the vees. The bottom of the table T-slots is cut out at fixed intervals to permit the chips to fall through. This results in the T-slots being kept clean and always ready for receiving clamping bolts. The housings are designed to take the heavy thrust of the side-head tools on square sections.

On all slides the dovetail is inverted so as to give a heavy cross-section through the center. This design is said to cause the dovetail bearings to become tighter under pressure. Taper gibs are provided for all sliding surfaces. Herringbone gears are used in the drive with a view to eliminating side thrust, obtaining a self-balancing unit, and securing long life. All gears and the table rack are made of steel. The gears in the bed revolve with their shafts which, in turn, rotate in ground bearings.

Continuous lubrication of all parts has been provided. A pump in the bed draws oil from a tank through a strainer and passes it through a filter to insure clean oil. The oil is forced into the vees near the center of the bed and distributed through channels running the full length of the table, so that the table constantly rides on a film of oil. An abundance of oil is always present on both short

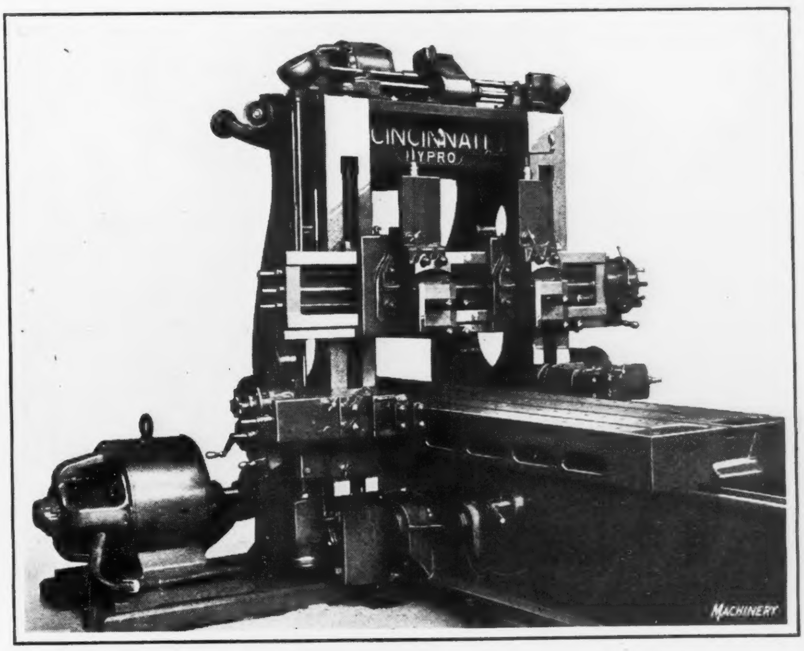


Fig. 2. Opposite View of Cincinnati Planer, showing Motor Drive

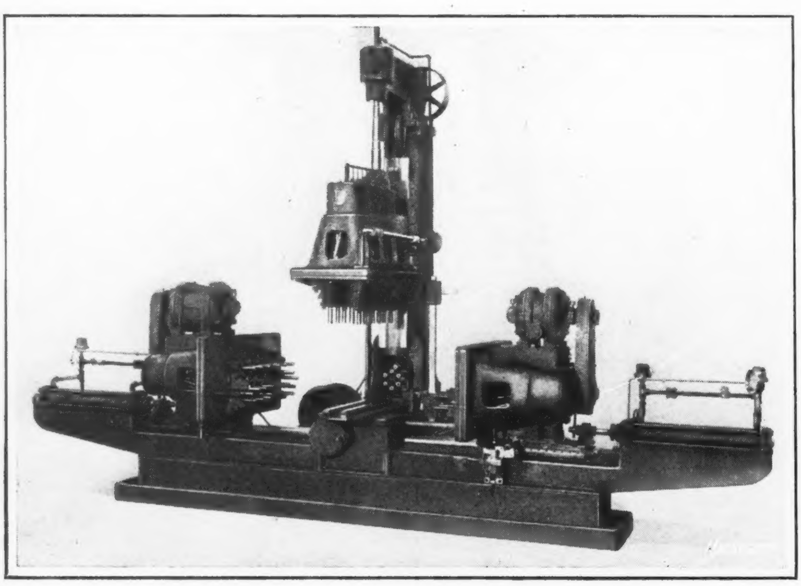
and long strokes, the overflow forming a wave in the vees in front of the table, which flushes small particles of dirt into the strainers at the ends of the bed and thus keeps the vees clean. Sufficient oil flows constantly to the large chambers surrounding the main bearings to keep them filled. This oil is again filtered by felt wicks before reaching the bearing. A steady stream of oil is spread over all gears, this method permitting the location of the gears above the oil pan and eliminating the distribution of sediment which in time comes to the bottom of the pan.

Centralized oil distributors which require filling only about once in ten days are placed on each side-head, on the elevating mechanism, on the rail, and on each of the rail-heads. The distributors lubricate not only revolving parts but also all sliding surfaces. The oil reaches sliding surfaces in the center, and tends to keep out dirt and give a long life to parts that often receive scant attention.

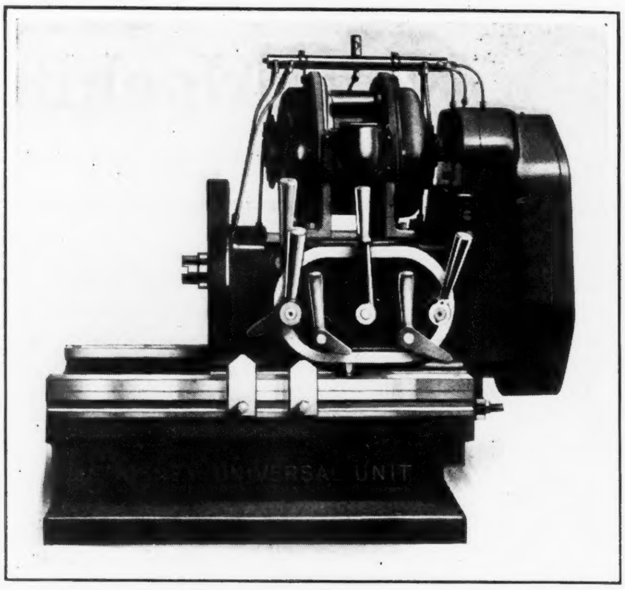
FOX FOUR-HEAD DRILLING MACHINE

A machine equipped with one vertical and three horizontal multiple-spindle heads was recently built by the Fox Machine Co., Jackson, Mich., for simultaneously drilling sixty-eight holes in an automobile engine cylinder block. One and one-eighth inch spindles are furnished on the left- and right-hand horizontal heads, and 1 3/8-inch spindles on the vertical and auxiliary horizontal heads. The spindles of three of the heads are mounted on cluster blades and driven through universal joints. Those of the left-hand head are driven through chain by a 10-horsepower motor, and those of the right-hand head by a 5-horsepower motor. A 15-horsepower motor drives the spindles of the vertical head through the medium of a belt and those of the auxiliary head through a chain.

The feeding of the heads is controlled by an Oilgear pump at the rear of the machine, which provides pressure to horizontal cylinders mounted at both ends of the bed. These cylinders are connected directly to the horizontal heads on the bed which, in turn, are connected by means of racks and pinions to the vertical and auxiliary heads. With this arrangement, when oil pressure is delivered to the horizontal cylinders, all heads are moved simultaneously toward the work at the rate of 90 inches per minute. When the drilling position is reached, the feed is automatically reduced to 2 inches per minute. After the work has been drilled to the predetermined depth, the movement of the heads is automatically reversed and they are withdrawn to the starting position at the rate of 90 inches per minute. Any of the heads can be disconnected from the others, and forced-feed lubrication is provided for all of them.



Fox Four-head Drilling Machine equipped with an Oilgear Feed Control



Stickney Universal Unit designed for Use with a Multiple-spindle Head and a Work-holding Device

STICKNEY UNIVERSAL UNIT

A machine known as the "Stickney universal unit" which may be used to perform drilling, tapping, boring, reaming, and facing operations on a production basis, constitutes the latest product of the Rockford Drilling Machine Co., Rockford, Ill. With this machine as the unit of construction, a drilling machine can be built up for any specific job. To form a complete machine, there must also be provided an auxiliary multiple-spindle drill head, sub-base, and work-table. The table may be of a rigid, rotary, or drum type, and of plain or automatic design.

Multiple-spindle drill heads with fixed center distances between the spindles are attached to the front of the universal unit, while drill heads on which the center distances of the spindles are adjustable have a bearing on the ways of the bed, in addition to being fastened to the flange of the head. Fixed-center and adjustable-center drill heads are built with any number of spindles within the range of the motor capacity and with any drilling area. Jigs and tools are also made to suit requirements. One of these units can be quickly applied to a number of production jobs. Five sizes are built, equipped with 3-, 5-, 10-, 15-, and 25-horsepower motors, respectively.

The unit consists of a body having integral square ways that are fitted to slide on a base as shown in the illustration or on a vertical column. Mounted on the body is a motor, which drives the spindle through pick-off change-gears, and the body contains the entire feed mechanism, which is driven from the main driving spindle. The feed is accomplished through a screw and nut. The drive from the motor to the spindle is through spur gears which run in a case and are flood-lubricated. High-speed shafts are equipped with self-aligning annular ball bearings, and all other bearings are bronze-bushed. In the drive is included a keyless jaw clutch which can be readily engaged and disengaged.

In addition to the power feed, there is a power rapid traverse for moving the head to and from the work. When it is desired to traverse the head rapidly with the spindles dead, a small auxiliary motor equipment can be supplied. In using the power feed or the rapid traverse, the feed-nut is revolved by a train of spur gears between which jaw clutches are interposed. Three feeds are obtained through a key, and pick-

off change-gears give a larger range. To take care of both drilling and tapping operations, feeds of 0.002 to 0.250 inch per revolution are provided. Feeds for back facing cuts are also obtained through change-gears. The Nos. 0, 1, 2 and 3 machines are operated at a normal speed of 500, 400, 350, and 300 revolutions per minute, respectively. Through the use of change-gears, any speed from twice to one-half the normal speed can be obtained. Other speeds are available through the use of special gears in the drill heads. In setting up work and in spot-facing operations, the head can be fed by hand by simply revolving a handwheel.

The movements of the head are always under the control of the operator. He can hold it at rest, feed it by hand or power, and traverse it rapidly in either direction by operating one of two levers. Two cycles of automatic control are provided, one for drilling, reaming, and boring operations and the other for tapping operations.

All gearing and feed-nuts are enclosed and flood-lubricated. Oil is injected at the highest point of each gear-case and at the principal bearings so that the oil can be conveyed by gravity to the lowest point, from which it is led to a common sump. From the sump the oil is passed through a filter and then again picked up by the pump. The sub-base is used as a coolant tank, and a pump and piping are provided for delivering the coolant to the work. Both the coolant and the lubricant pumps are driven by one motor.

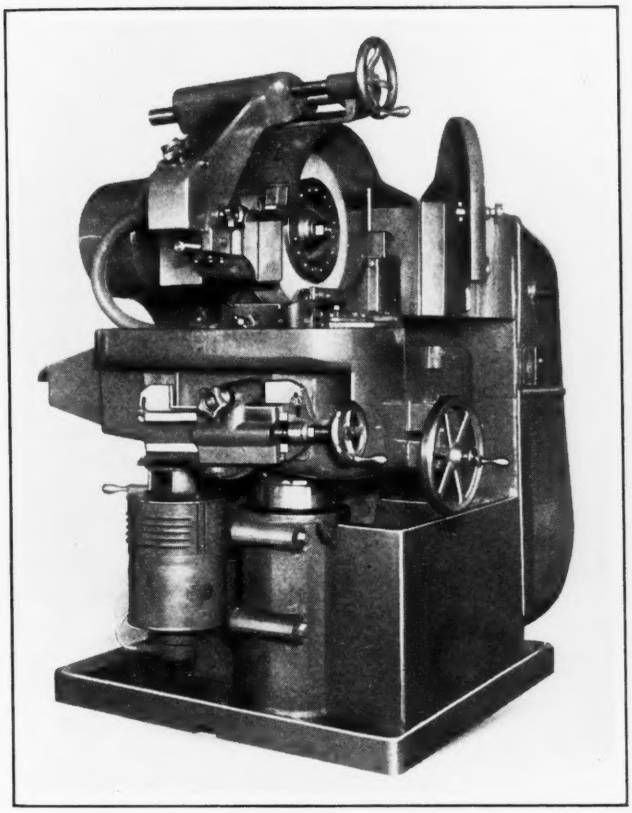


Fig. 1. Detroit Centerless Grinding Machine of Improved Construction

DETROIT CENTERLESS GRINDING MACHINE

An improved No. 4-C centerless grinder of the vertical type has recently been developed by the Detroit Machine Tool Co., Detroit, Mich. This machine is designed on the same principle as earlier models built by the company in that the grinding wheel is located directly above the work feed-wheel. The work rests of its own weight on this wheel, and is rotated and traversed by it past the grinding wheel. Owing to the fact that the feed-wheel is twice the width of the grinding wheel, the work is rotated before it reaches the grinding wheel and after it leaves it. With this arrangement, pressure from the grinding wheel is not necessary to produce rotation of the work.

While the work is being passed through the machine by the feed-wheel, it is held accurately in position by guide blades at the front and rear. The bracket that carries these guides is mounted in such a way that a constant relation is maintained between the blades, the work, and the grinding wheel, irrespective of adjustments of the feed-wheel. The feed-wheel unit can be pivoted to bring its axis at an angle with the axis of the grinding wheel and the guide blades. The amount of this angle, in connection with the rheostat control for the variable-speed motor which drives the feed-wheel, determines the rate of travel of the work through the machine. Feeds from 1.69 to 89.6 feet per minute are available.

The depth of cut taken by the grinding wheel is controlled by raising or lowering the entire feed-wheel unit to alter the distance between the wheels. This is accomplished by turning a handwheel that operates worm-gearing which, in turn, drives a jack-screw in the column. Accurate adjustments are possible through the use of a dial attached to the handwheel, which reads in ten-thousandths of an inch. The graduations on the dial are spaced 1/4 inch apart.

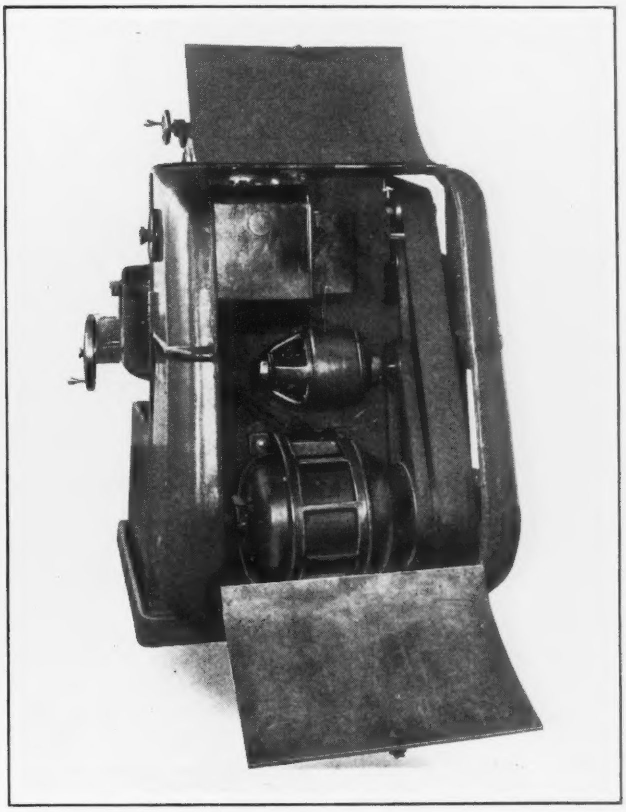


Fig. 2. Manner of installing most of the Electrical Equipment in the Machine

The grinding wheel spindle is of heavy construction, and is provided with a front bronze bearing, 3 1/2 inches in diameter by 10 inches long. This bearing is adjustable, and oil flows constantly through it. At the rear end of the spindle is a roller bearing having a capacity of 5090 pounds with the spindle rotating at 1500 revolutions per minute. The outer race of this bearing is pressed into the head and then lapped, while the inner race is pressed on the spindle and then ground. The roller bearings are next ground and lapped to fit between the two races. End thrust is taken by radial ball bearings.

Oil is automatically circulated to the spindle, when it is running, from a large reservoir equipped with a gage glass to show the oil level at all times. Felt washers and threads on the ends of the spindle prevent water or emery from working into the bearings. Both the grinding wheel and drive pulley are mounted on taper seats on the spindle so as to insure accurate seating and eliminate end play. The feed-

wheel spindle is supported in a babbitt bearing, ¾ inch in diameter by 8 inches long. This bearing is lubricated through an oil reservoir in the gear-box, and end play is taken care of by spring tension.

The grinding wheel is driven by an individual motor. When alternating current is used, a generator is provided to furnish direct current to the variable-speed motor that drives the feed-wheel. All electrical equipment, with the exception of the variable-speed motor, is housed in the rear of the machine, as may be seen in Fig. 2, which shows the upper and lower covers thrown open.

TAYLOR & FENN SPRING PRESSES

Several types of uniform-blow spring presses, designed to do the work of foot presses and light drop-hammers, are being introduced to the trade by the Taylor & Fenn Co.,

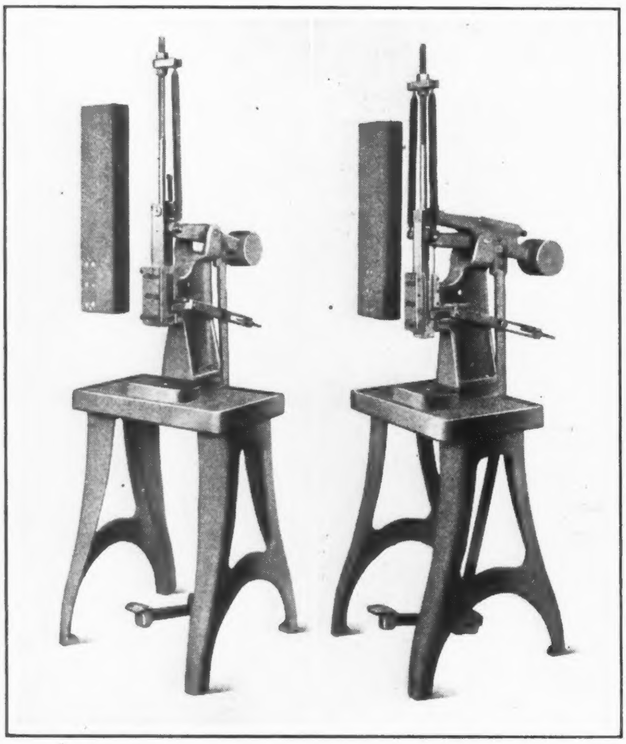


Fig. 1. Taylor & Fenn Single- and Double-action Spring Presses

Hartford, Conn. These machines differ essentially from a kick press in that the blow is governed entirely by spring tension. After a machine has been adjusted to strike a blow of predetermined force, it will continue to do so, regardless of variations in the thickness of the work or the effort exerted by the operator. The force of the blow may be quickly regulated from a few pounds to 150 pounds by simply adjusting the spring tension and changing the length of the stroke.

A single-action type of press is shown at the left in Fig. 1, equipped with one spring, but two springs can be furnished. The machine shown at the right in the illustration is of a double-action type which can be used to advantage in staking, riveting, and embossing operations. In the operation of these machines, the foot-treadle is depressed to first add tension to the springs and then withdraw a latch and release the ram. The ram is driven down by the quick contraction of the spring. The return movement of the counterbalanced foot-treadle lifts the ram to its original position where it is locked in place until the treadle is again depressed. Adjustment of the stroke is accomplished by simply turning a screw in the latch link.

The hammer of the double-action press is equipped with a sleeve, on the end of which is fitted a pad for holding down two or more pieces while work is being performed on them. The single and double-action presses weigh 410 and 435 pounds respectively. Their stroke is adjustable from 1/2 to 3 3/4 inches.

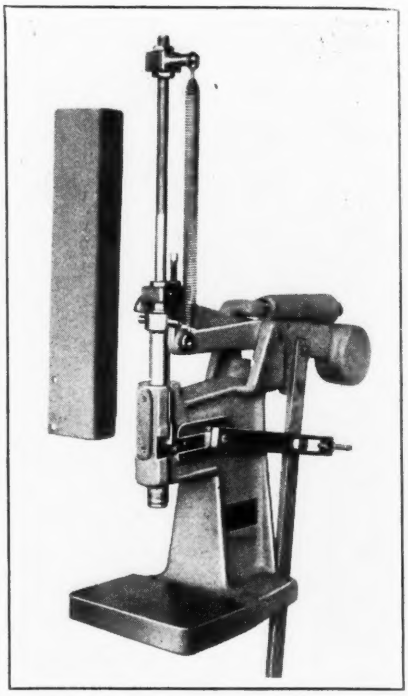


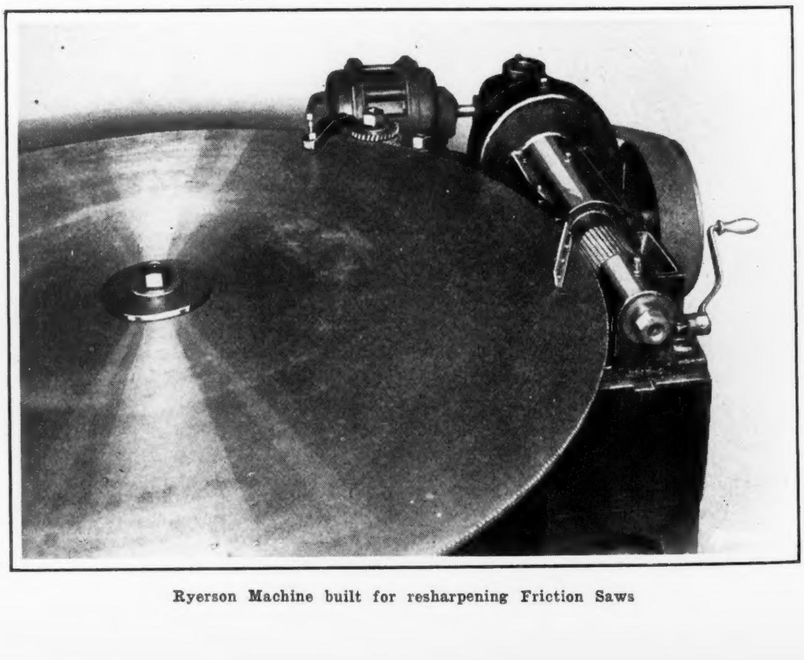
Fig. 2. Bench Style of Double-action Spring Press

Fig. 2 shows a double-action bench machine on which the force of the blow may be regulated from a few ounces to 50 pounds. The stroke of this machine may be adjusted from 1/2 to 2 3/4 inches, and the machine weighs 85 pounds.

RYERSON SAW RECONDITIONING MACHINE

It has been the practice to sharpen friction saw blades by forming nicks around the periphery with a hammer and cold chisel. However, this method has several disadvantages, one of which is that the blade is seldom nicked uniformly and to the proper size. Furthermore, as the metal is merely displaced by the chisel, the rim of the saw is widened and this increases the power consumption and the amount of waste on each cut. To permit the operation to be performed in a more satisfactory manner, Joseph T. Ryerson & Son, Inc., 16th and Rockwell Sts., Chicago, Ill., have developed a machine that employs a hob for sharpening and trimming the saw blades.

The machine consists primarily of a centering and leveling frame, which holds the blade horizontal, as shown, while the hob is applied to the edge to mill the desired grooves and trim the rim so that the periphery is true. At the same time, the hob revolves the blade. At another point along the

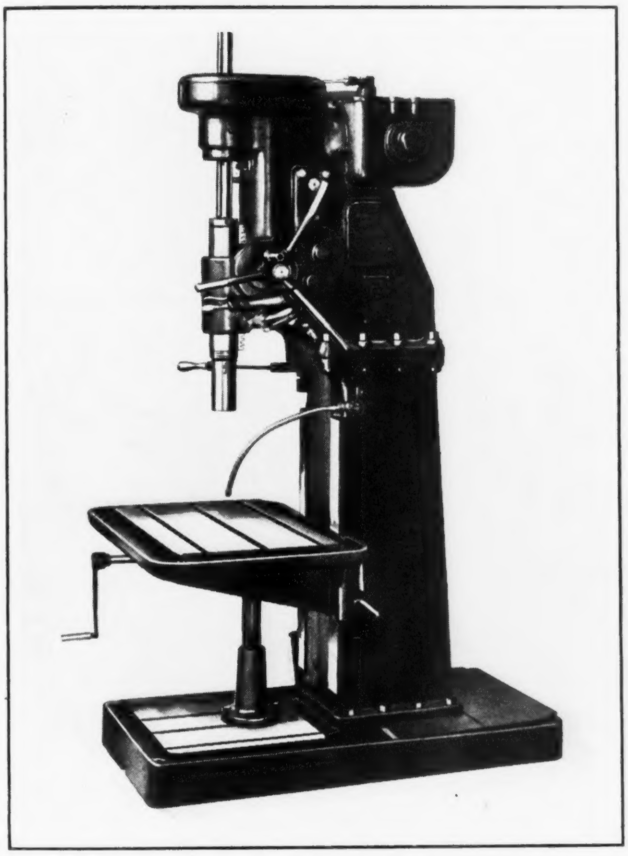


Ryerson Machine built for resharpening Friction Saws

periphery of the blade, a pair of milling cutters removes the slight mushroom effect produced on both sides of the blade from the action of the hob. Hobs and milling cutters are provided for forming teeth in any standard make of blade, regardless of the hardness of the steel. Teeth are cut according to the specified size, at the proper angle, and spaced evenly.

BARNES DRILL CO.'S DRILLING AND TAPPING MACHINE

A description of the motor-driven No. 210 all-geared drilling and tapping machine brought out by the Barnes Drill Co., 814 Chestnut St., Rockford, Ill., was published in November, 1924, MACHINERY. This machine is now also built with a clutch-pulley drive as illustrated, a multiple-disk clutch being used to drive the spindle in the drilling direction, and in the reverse direction when the machine is equipped with an automatic tapping reverse. This clutch is contained in the box that encloses the bevel driving gears.

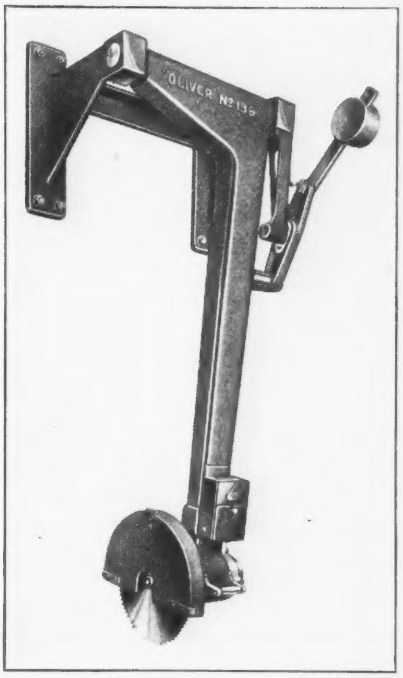


Barnes Drill Co.'s Drilling and Tapping Machine

There is a vertical shaft on the right-hand side of the machine on which is mounted a hand-lever which can be located in any position to suit the operator. This handle is actuated to engage or disengage the clutch. At the instant the clutch is disengaged, a brake bearing against the hub of the driving gear automatically stops the spindle. Six splines are provided on the spindle instead of keyways with a view to preventing binding of the spindle in the crown gear when tapping or doing heavy work.

OLIVER SWING SAW

A swing saw, the head of which is adjustable vertically and which is driven by a motor mounted directly on the arbor of the saw, is being placed on the market by the Oliver Machinery Co., Grand Rapids, Mich. The vertical adjustment is of value in setting up for a particular job, and in compensating for wear of the saw. The hanger is of such a design that the machine can be mounted on either the walls or ceiling without any change other than placing the weight arm properly. A slot is provided in the weight arm that acts as a safety device by bringing the saw to the proper starting position. The motor has a full-load speed of 3450 revolutions per minute. The saw arbor is made of crucible steel, ground, and mounted in two radial ball bearings that are pressed on. An 18-inch saw may be applied to the machine, but a 16-inch saw is regularly furnished.



Oliver Swing Saw

MURCHEY DOUBLE-END THREADING MACHINE

A machine designed to automatically thread, ream, chamfer, and drill either one or both ends of pipe nipples, studs, piston-pins, bushings, etc., in one operation, has recently been designed by the Murchey Machine & Tool Co., 34 Porter St., Detroit, Mich. A feature of this machine is that the chucking and holding of the work and the movement of the tool-spindles are all accomplished by the use of air. Air cylinders cast in one block control these movements, and the admission of air into the cylinders is governed by a series of valves operated by cams. These cams are adjustable so as to admit any amount of air into the cylinders and allow any amount to exhaust from them. This arrangement permits a flexible adjustment of the speed of the chucks and spindles. All movements of the different parts are under one control and are geared together.

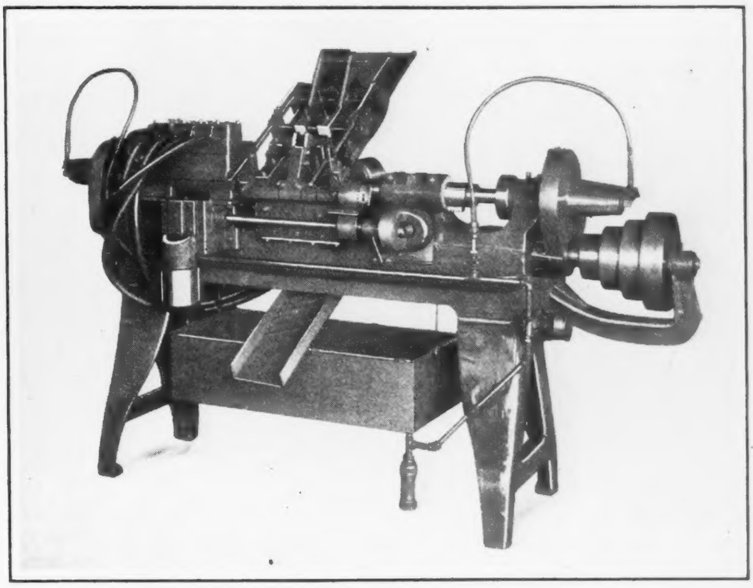


Fig. 1. Murchey Automatic Double-end Threading Machine

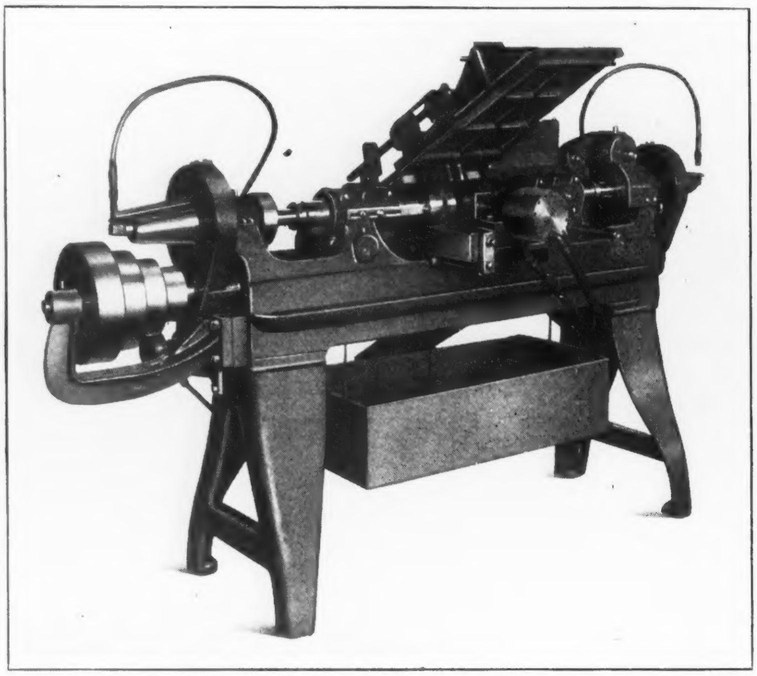


Fig. 2. Rear Side of the Murchey Threading Machine

In the operation of this machine, the operator is simply required to feed the pieces into the hopper, the machine automatically performing its cycle and ejecting the pieces. The pieces roll from the hopper down a chute which can be quickly adjusted for length and height. At the bottom of the chute each piece is picked up by fingers that carry it down between the chucks where it is held until the chucks advance to it. The tool-spindles then come forward, machine the piece, and reverse. During the reversal another piece rolls down and is picked up by the fingers, which bring it into position for machining on the next forward movement of the spindles. The extent of the spindle and chuck movements is governed by air. As the air escapes from the exhaust side of the cylinders, a cushion effect is obtained for the tools. One operator can run two or three of these machines.

CLEVELAND BUFFING AND POLISHING MACHINES

Two new buffing and polishing machines known as the "extra heavy-duty double spindle" and the "heavy-duty single spindle" have been added to the line of machines built by the Cleveland Armature Works, Inc., 4732 St. Clair Ave., Cleveland, Ohio. One of the features of both machines is the chain drive from motors mounted close to the spindles. The double-spindle machine shown in Fig. 1 consists of a casting that forms the motor base, central chain box, and the spindle housings. Special motors with flanged end bells are bolted to each side of the chain box with their shafts projecting into the box through slotted openings. These openings permit the motors to be moved back in order to take up chain slack.

Fig. 1. Cleveland Double-spindle Buffing and Polishing Machine

The spindles are mounted in tubes which are part of the main casting, and one end of the spindles projects into the chain box. The latter is closed tightly, and holds two gallons of oil into which oil slingers on the motor shafts dip, keeping the chains and sprockets constantly bathed in oil. The shafts are made of chrome-nickel steel and mounted in Timken tapered adjustable roller bearings, of which there are eight. Each spindle is provided with a lock that holds it rigidly while changing wheels.

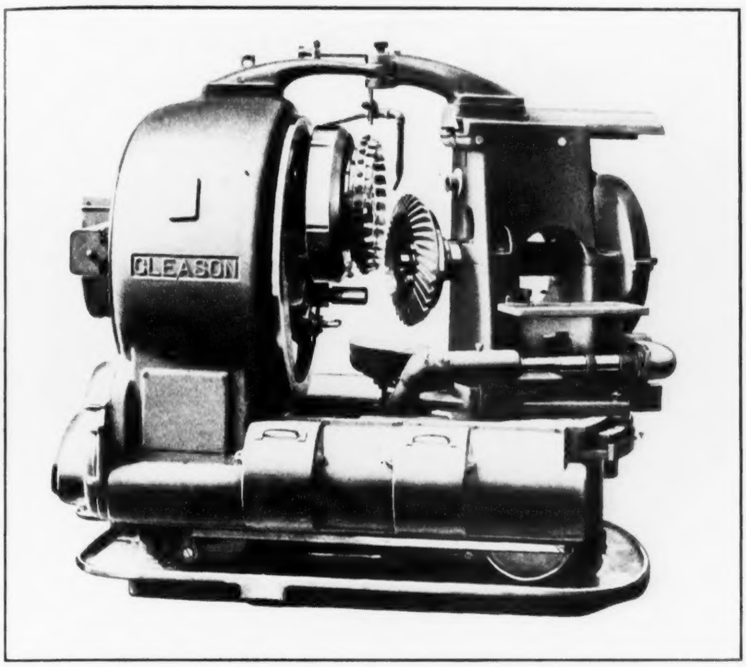
The right-hand and left-hand halves of the machine are independent mechanically and electrically, and can be run at different speeds. The standard speeds with 60-cycle current are 2300, 2600, 2900, and 3100 revolutions per minute, and with 25-cycle current 2300, 2600, 2800, and 3100 revolutions per minute, but special speeds can be arranged for. The double-spindle machine is built in four standard sizes, with over-all spindle lengths of 48, 58, 60, and 70 inches, respectively. The weight ranges from 1500 to 2000 pounds.

Fig. 2. View of the Single-spindle Machine, showing the Drive

The single-spindle machine is equipped with one motor that drives the spindle by means of multiple chains, as illustrated in Fig. 2, where the enclosing housing has been removed in order to show the construction clearly. In this case also the motor can be adjusted to take up chain slack. The standard spindle speeds of this machine, with both 25- or 60-cycle current, are 2200, 2500, and 2800 revolutions per minute. There are two frame sizes having over-all lengths of 48 and 60 inches, respectively, and weighing from 1200 to 1500 pounds.

GLEASON SPIRAL BEVEL GEAR GENERATOR

Several new features are incorporated in a spiral bevel gear generator that has just been placed on the market by the Gleason Works, Rochester, N. Y. This is rated as a 25-inch machine, but as in the case of other bevel gear cutting machines of the Gleason line, this rating does not represent the largest diameter of gear that can be handled. Gears or pinions having a cone distance not over 16½ inches can



Gleason Spiral Bevel Gear Generator

be cut. This includes gears of 8 to 1 ratio, 32.75 inches pitch diameter; of 3 to 1 ratio, 31.2 inches pitch diameter; and of 2 to 1 ratio, 29.5 inches pitch diameter.

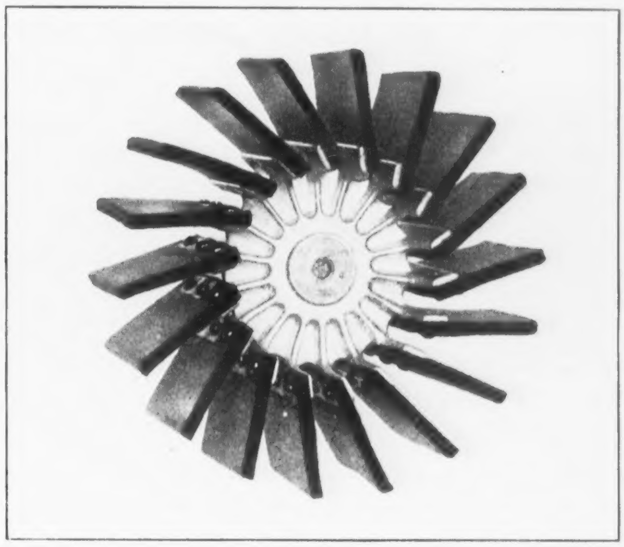
From the illustration it will be seen that the machine is equipped with an overhead tie for bracing the cutter and the work. The cutter is set in a cradle running in a completely enclosed housing, which gives a rigid construction. In roughing out cast-steel miter gears having full-depth teeth of 1½ diametral pitch, and 4-inch face, it has been possible to do the operation at a speed of 1 minute 50 seconds per tooth with a cutter having a point width of 0.400 inch. Another feature of the machine is the indexing mechanism, which is of the stop wheel type. However, the index change gears are placed in the constantly moving train of gearing that drives the generating movements of the machine. With this arrangement, there are no dead gears in the generating train, and accuracy of indexing and tooth profile is obtained.

A third feature to which particular attention is called is the design of the cutter-spindle. It can be adjusted for end play and radial play independently, and without dismantling the spindle. Lubrication of the bearings of this spindle is accomplished by a self-contained system so that there is no chance of dirt finding its way into the bearings. The generating roll ratio is obtained by means of change-gears. The ends of the gear train are worm-wheels which are split in two and hobbed by the Whitworth method. In this method, the hob drives the wheel, and errors are continually halved by changing the relative positions of the two sides of the wheel and rehobbing until there is no mismatching of the teeth when a shift is made.

Cutters 18, 12, and 9 inches in diameter can be used, and the largest pitch for which the machine is recommended is 1 1/2 diametral pitch. Lubrication of the cutter-head is effected by a unit system, which takes care of all points that require lubrication except the spindle bearings for which, as explained previously, there is a separate system. There is also an individual system for lubricating the work-spindle. An ample supply of coolant is delivered to the work by a geared pump. The machine can be arranged for either motor or belt drive with a 7 1/2-horsepower constant-speed motor. The weight of the machine is about 14,000 pounds.

STRAND "MULTIPAD" BUFFING WHEEL

A buffing wheel constructed with a metal center and a multiple number of pads made from felt or other materials used in various kinds of buffing has recently been placed on the market by N. A. Strand & Co., 5001 N. Lincoln St., Chicago, Ill. This "Multipad" wheel was primarily designed for buffing lacquered parts after the sanding and rubbing down operation. It is 8 inches in diameter, 3 inches wide, and conforms readily to the moldings and curvatures of auto-

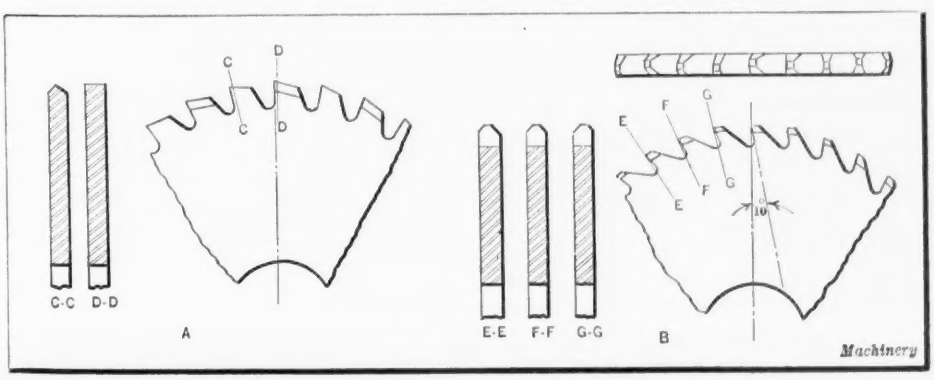


"Multipad" Buffing Wheel

mobile bodies and similar work. It is used with Strand flexible shaft machines of 1/4 horsepower capacity and a 7-foot flexible shaft.

METAL SLITTING SAWS

Two new types of metal slitting saws have recently been placed on the market by the National Twist Drill & Tool Co., Detroit, Mich. The saw shown at *A* in the illustration has formed teeth, and is designed especially for cutting metals of a soft, spongy nature such as copper, brass, and bronze. The teeth are cut radial, and the sides ground concave. Every other tooth is ground with a 45-degree bevel on each side, as shown in section *C-C*, while the alternate teeth are plain, as shown in section *D-D*. This design distributes the cut and breaks up the chips. The comparatively large space between the teeth prevents chips from clogging, which is the tendency with soft materials, especially



Slitting Saws recently brought out by the National Twist Drill & Tool Co.

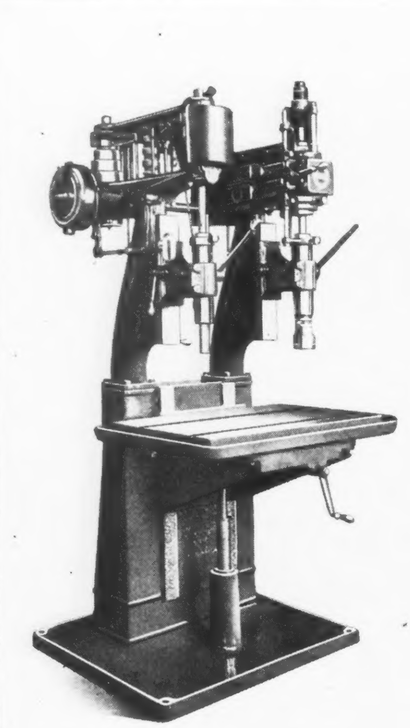


Fig. 1. "Hy-Speed" Combined Drilling and Tapping Machine

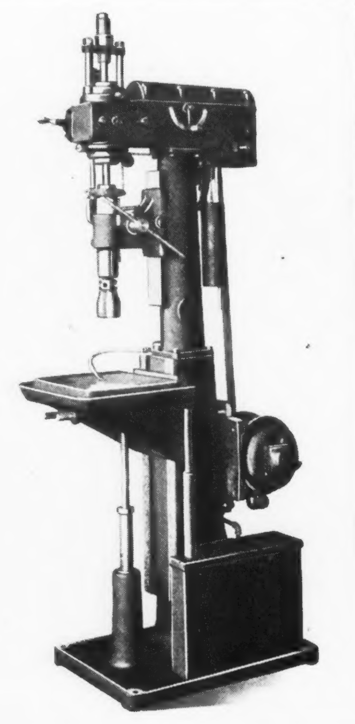


Fig. 2. "Hy-Speed" Automatically Controlled Tapping Machine

when cutting deep slots. A typical application of this saw is the cutting of armatures to length, in which operation the saw cuts through copper, mica, and a wood plug.

At *B* in the illustration is shown a "connecting-rod" type of slitting saw, which is so called because of its successful use on connecting-rods and other drop-forged steel parts. The teeth are under-cut to a rake angle of from 7 to 10 degrees, and the sides are ground concave. Teeth *E–E* and *G–G* are ground with a 45-degree bevel on each side, but in a staggered relation to each other. Tooth *F–F* is ground with a 45-degree bevel on each side to prevent the corners from chipping and breaking. The staggered effect of the teeth breaks up the chips and makes it possible to take a deeper cut.

"HY-SPEED" DRILLING AND TAPPING MACHINES

A tapping machine, the base, column, and table of which are designed along the same lines as the regular line of "Hy-Speed" drilling machines, has recently been brought out by the Cincinnati Hy-Speed Machine Co., 212 Lawrence St., Cincinnati, Ohio. This machine, as shown in Fig. 2, has a capacity for tapping holes up to 7/8 inch in cast iron, and up to 3/4 inch in steel. The movements are automatically controlled with a view to permitting high production in tapping operations.

This tapping machine may also be built like one of the more recent designs of "Hy-speed" drilling machines, with the upper portion of the column made as shown in Fig. 1, where the offset in the column permits of a 12-inch overhang thereby increasing the capacity as compared with the regular 6½-inch machine illustrated in Fig. 2. The table of the tapping machine may also be made on the same principle as the table of the machine shown in Fig. 1—that is, in two pieces having a knee independent of the table proper, so that any type of table can be fitted to the knee. All parts used in the 12-inch overhang tapping or drilling machine are the same as those used in the standard 6½-inch machine, except that the upper part of the column is made as shown.

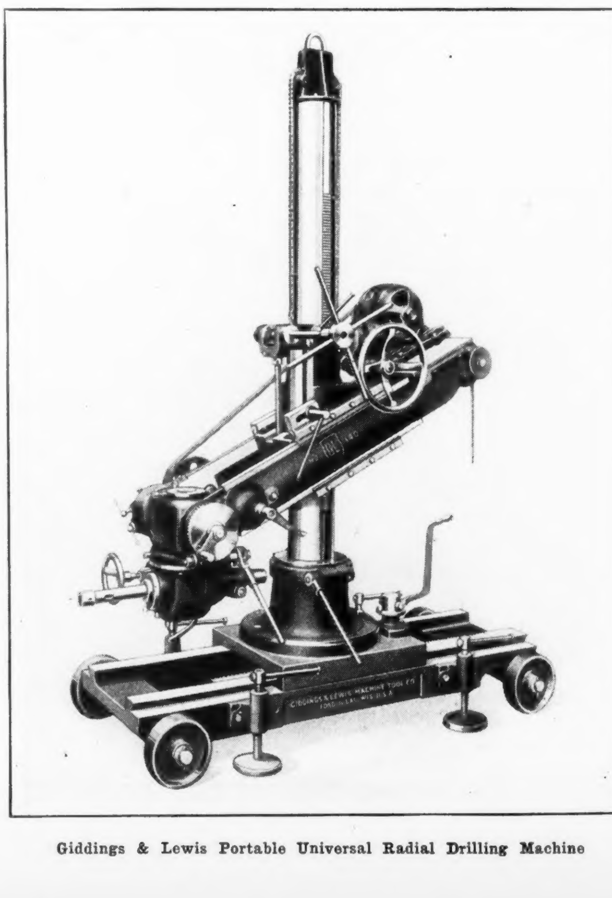
Fig. 1 shows the combination drilling and tapping machine made by the company, one spindle of which drills while the other one taps. These machines can also be built with any combination of spindles and with any number of spindles required for the work in hand.

GIDDINGS & LEWIS UNIVERSAL RADIAL DRILL

A large variety of drilling, boring and tapping operations can be performed by means of the portable universal radial drilling machine here illustrated, which has been added to the line of the Giddings & Lewis Machine Tool Co., Fond du Lac, Wis. The principal feature of this machine is that the drill spindle unit can be positioned for drilling holes in any direction, enabling the operator to reach otherwise inaccessible places in complicated castings or machine parts. The machine is arranged for a belted motor drive, with the motor mounted on the radial arm.

The column is of a heavy tubular section and well braced to withstand strain. After being machined, it is ground to diameter. The arm is of box construction and has a movement of 360 degrees about the column. It is provided with a device for clamping it to the column in any desired position, and is operated by a lever mounted on the head which is within easy reach of the operator. Angular adjustment of the arm up to 20 degrees in both directions is provided to permit a large range of operations. The arm is counterbalanced by means of a weight within the column of the machine.

The speed and feed box is a self-contained unit which provides six spindle speeds and two feeds on the two smaller sizes of this machine, and nine speeds and six feeds, on the two larger sizes. The levers and handwheels for changing the speeds and feeds are within easy reach of the operator. The gears run in oil and are entirely enclosed, but they can be conveniently inspected by removing a cover. The drill-spindle unit can be adjusted 360 degrees horizontally and 180 degrees vertically relative to its axis for setting the spindle in any position. The head may be quickly clamped in position by means of a cam. Thrust of the spindle is taken by a large ball bearing.



Giddings & Lewis Portable Universal Radial Drilling Machine

The portable base is provided with a planed runway for the supporting platen of the column, and a rack, pinion, and ratchet lever are furnished for moving the machine along this runway. The portable carriage may be held securely to the floor by tightening four disk-headed screws. Only the two smaller machines are mounted on a portable truck, but all four can be furnished with a stationary runway, and the two larger sizes can be built on a round base on which the radial arm can be swiveled about the column.

The same concern has recently developed a machine of much the same design as the style illustrated, which is intended primarily for use in locomotive, railway car, tank, and boiler shops. Holes can also be drilled, bored, and tapped in any direction by using this machine.

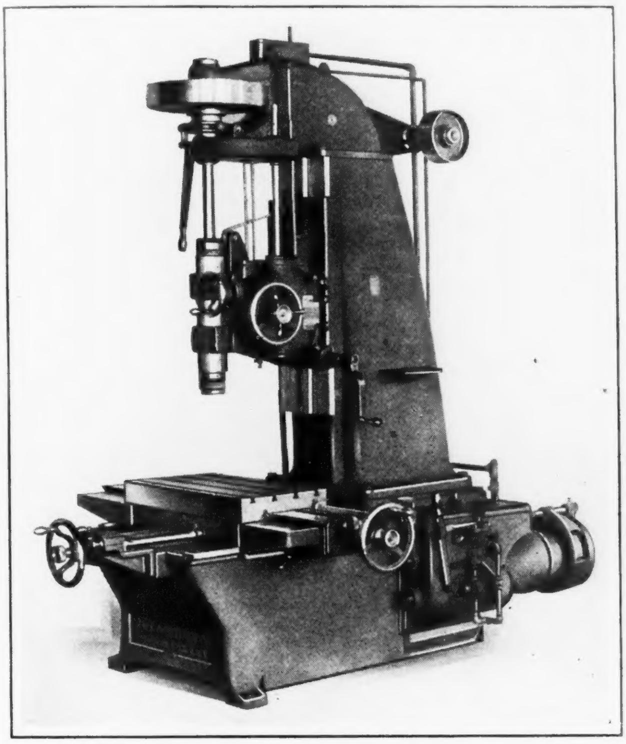


Fig. 1. Pratt & Whitney Improved Jig Boring Machine

PRATT & WHITNEY JIG BORING MACHINE

An improved model of the jig boring machine built by the Pratt & Whitney Co., Hartford, Conn., has recently been placed on the market. Chief among the improvements is the redesigned column, which has been made heavier to give the rigidity necessary for the accurate boring for which the machine is intended. The column head has been changed to conform to the new column, and the spindle-speed gear-box has been reduced in size. The spindle head has been made larger and heavier and been given a greater amount of bearing surface on the face of the column. The devices for measuring the transverse and longitudinal movements of the table have also been improved.

This jig boring machine is equipped with fine measuring devices provided with sensitive indicator dials to adapt it to the precise work of making jigs as well as other toolroom work requiring a high degree of accuracy. The machine is purposely equipped with a belt drive to the spindle, as with this arrangement, the power delivered to the machine can be limited so that the accuracy of the machine cannot be damaged by heavy overloads. Power may be taken from a countershaft or delivered by a motor mounted on the side of the bed. In either case, the drive is to a pair of tight and loose pulleys on the rear of the speed gear-box, and from these pulleys through the gear-box to a large pulley on the rear of the bed. From here the power is transmitted to the spindle pulley by means of a belt running over two idlers. The spindle pulley is equipped with a hand-operated fric-

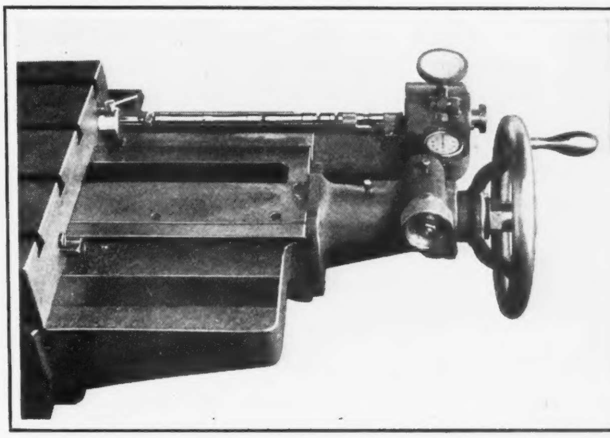


Fig. 2. Measuring Devices with which the Transverse and Longitudinal Slides are equipped

tion clutch to provide a control for the power delivered to the spindle and the spindle quill. Power is taken from the spindle to drive the gears contained in the spindle head. Speeds and feeds may be easily changed by means of levers on the two gear-boxes, and the spindle can be fed either by hand or power. Eight spindle speeds ranging from 22.2 to 300 revolutions per minute are available, and four feeds from 0.0025 to 0.010 inch per revolution of the spindle. The spindle head is locked in position for an operation and the vertical feed obtained through the quill.

The table is scraped on the top and on the four sides into alignment with the column and the spindle. Both the transverse and longitudinal slides are traversed by a screw equipped with both a slow-motion and a rapid-traverse handwheel. Each slide is also provided with a measuring device consisting of a combination of end measures, an inside micrometer, and an indicator dial, as illustrated in Fig. 2. The end measures are used to determine even inches; the inside micrometer, thousandths of an inch, and the indicator dial, ten-thousandths of an inch. With this method, after having established the spindle over the first hole to be bored, by using a proving bar or a button, it is easy to set the work accurately for boring the next hole.

"OHIO" UNIVERSAL AND TOOL GRINDER

A No. 2-L universal and tool grinder intended primarily for use in railroad and automobile shops for grinding gang and bridge reamers, boring-bars, taps, and similar tools has

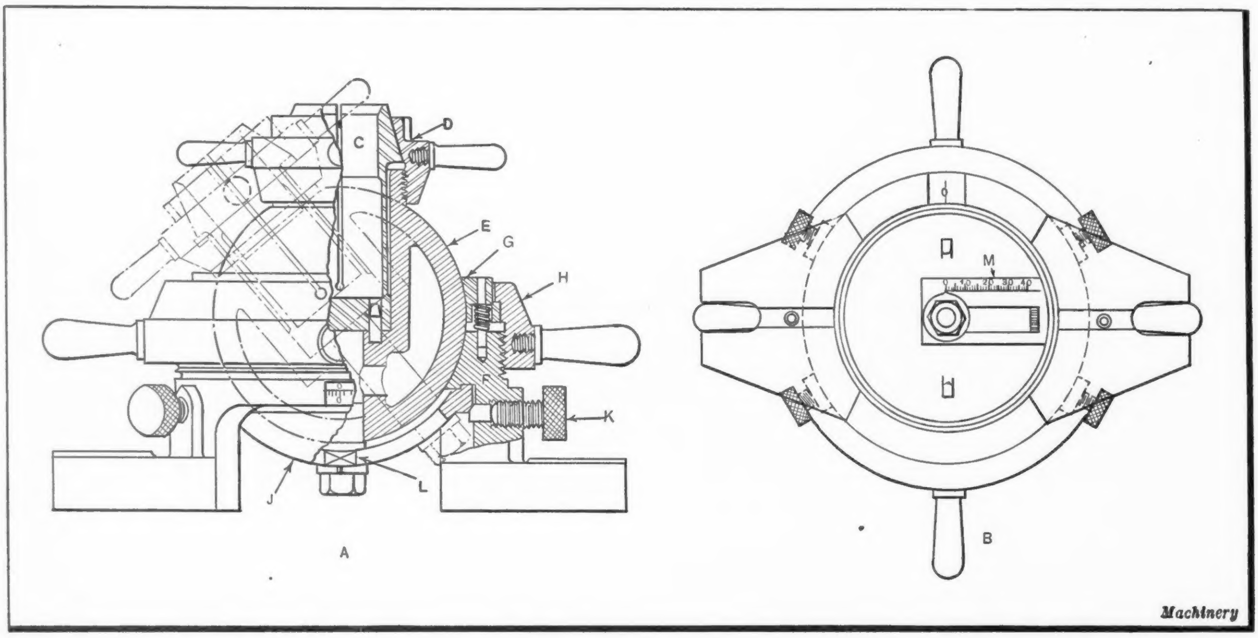
Universal and Tool Grinder built by the Oesterlein Machine Co.

recently been developed by the Oesterlein Machine Co., Cincinnati, Ohio. The machine will take work up to 30 inches between centers and 9 inches swing. There is a 7½-inch vertical movement. The machine is of the milling machine type of construction.

Table reciprocation may be obtained through a handwheel, in which case two gear ratios are available. In addition, a ball-bearing equipped lever feed is provided that may be engaged at any point to permit the operator to use either his right or left hand for reciprocating the table. This lever feed has also been added to the Nos. 2 and 3 grinders built by the company. The wheel-spindle can be set parallel to the table for using plain grinding wheels, or at right angles to the table for cup-wheels. Attachments for cylindrical, internal, and surface grinding operations may be provided.

GAIRING UNIVERSAL WORK FIXTURE

Work may be held at any angle up to 40 degrees either side of the vertical and at any angle in a horizontal plane by means of a universal fixture manufactured by the Gairing Tool Co., Inc., Detroit, Mich. While held in any angular position from the vertical, the work may be rotated or indexed about the angle of inclination for machining or grinding different faces, as of a milling cutter or counterbore. The fixture was primarily designed for use in resharpening counterbores made by this company, but it can be used for a large variety of operations, and it is also possible to mount the tool in the fixture instead of the work. A partial side and partial sectional view of the fixture are shown at *A* in the illustration, and a bottom view at *B*.



Gairing Universal Fixture designed for holding Work or Tools in Various Angular Positions

The fixture is ordinarily equipped with a collet *C* for holding the work, but a faceplate can be provided instead. The collet is expanded and contracted, respectively, as clamping ring *D* is screwed up and down on threads cut around a boss projecting from a spherical member *E*. Ball *E* fits snugly in a spherical seat in the base *F*, to which it is clamped by the ring *G* when the clamping collar *H* is screwed down on the threads of the base. Ring *G* is also shaped to suit the ball. Dowel-pins extend from this ring into base *F* to prevent the ring from rotating when the clamping collar is revolved. A dowel-pin similarly prevents the collet from rotating in its socket.

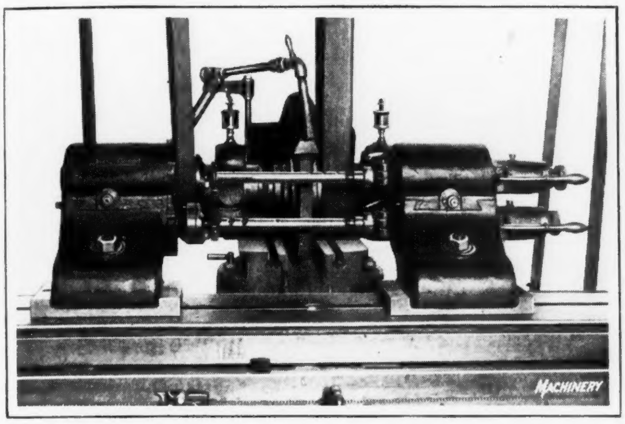
Into base *F* underneath ball *E* there is fitted a rotatable plate *J*. Several screws *K* are used to clamp this plate to the base after the plate has been rotated to bring the work into any desired position in the horizontal plane. From the center of the plate there extends a slot in which is fitted a square section of shank *L*, this shank being held in ball *E*. With this arrangement, the ball can be swiveled in the base to any desired position up to 40 degrees from the vertical when ring *G* and the nut on shank *L* are loosened. A pointer under the nut is referred to scale *M*, which may be seen in view *B*, to determine the angular setting. This scale may be observed through an opening in the base. After the ball has been positioned, the nut on shank *L* and clamping ring *H* are tightened to prevent the ball from changing its position during the operation.

When it is necessary to index the work after a cut has been taken on one of its surfaces, ring *H* is loosened to permit the ball to be turned about the cylindrical head of shank *L* until the desired position is reached. Ring *H* is then again tightened to keep the ball from changing its position while the operation is in process.

"HI-SPEED" DUPLEX GRINDING ATTACHMENT

Two cylindrical pieces can be ground simultaneously by means of an attachment recently developed by the Hi-Speed Machine Tool Co., 71 Willis Ave., W., Detroit, Mich., for application to grinding machines of standard make. The attachment is intended for installation on 10-inch machines after the regular work-holding heads have been removed, but it can be applied to larger machines by using filler blocks. Each head of the attachment is equipped with two spindles for supporting pieces of work above and below the axis of the grinding wheel. The lower spindles are adjusted relative to the grinding head in the same manner as they would be on a standard single-spindle external grinder. Then the upper spindles are positioned by means of a micrometer adjustment to correspond with the lower spindles. A locking device is provided, by means of which both the upper and lower spindles of the attachment are locked with one motion.

The tailstock centers are controlled by a spring that can be set to give any required pressure. These centers are withdrawn independently of each other far enough to admit and remove the work. They can be locked independently or together by one motion. Work up to 3 inches in diameter and to any length within the limits of the machine can be ground. It is claimed that by grinding a piece above and below the axis of the grinding wheel, vibration is overcome and a high finish obtained on the work. It is stated that in one operation 100 pieces, 6 inches long and approximately

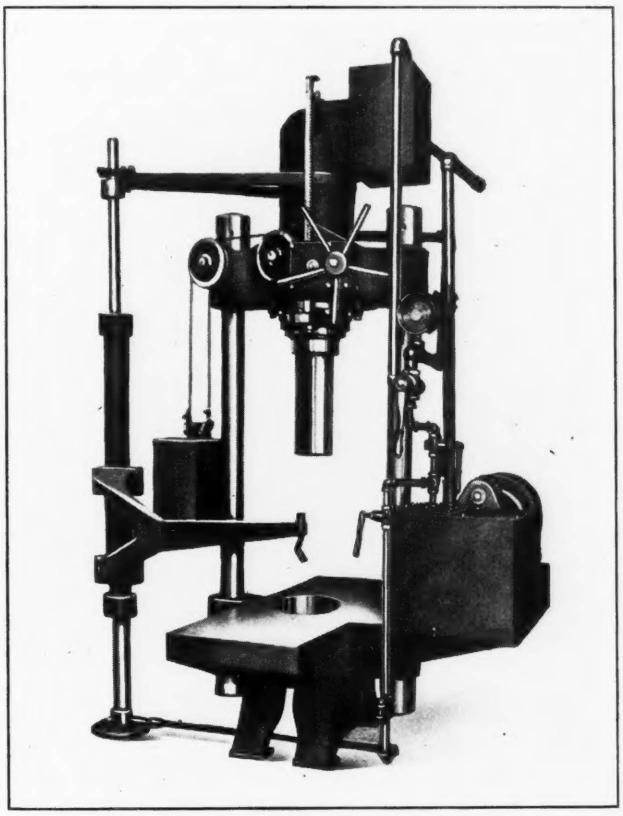


Attachment for grinding Two Pieces of Work at One Time

5/8-inch in diameter, were ground to two diameters within limits of 0.001 inch, in two hours. The vertical distance between the two spindles of the attachment is 3 1/8 inches.

HYDRAULIC GENERAL-PURPOSE PRESS

A vertical hydraulic press particularly adapted to general machine shop service has been brought out by the Hydraulic Press Mfg. Co., Mount Gilead, Ohio. This press is built in a number of different sizes, the 100-ton press being shown in the accompanying illustration. The extended pressure bed is provided with a central hole fitted with bushing plates, which adapts it to a wide range of forcing, bending, and straightening operations. A compact self-contained pump operates immersed in the pressure fluid, which is oil. The pump may be belt- or motor-driven.

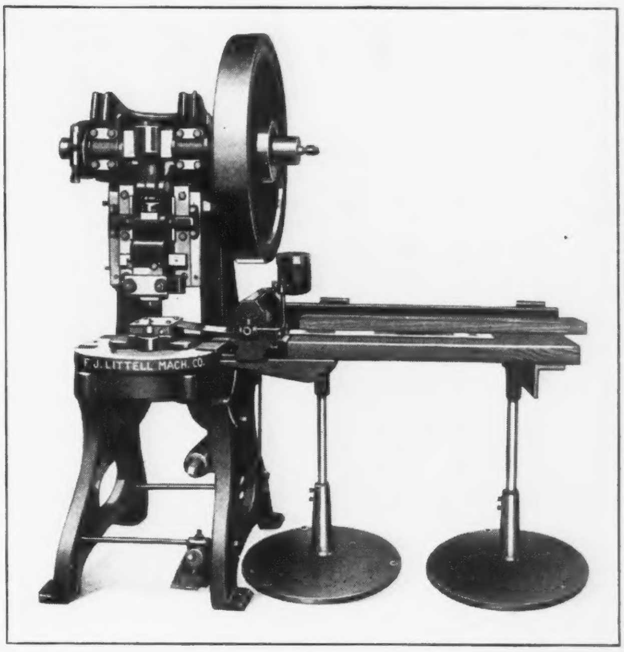


Vertical Hydraulic Press for General Machine Shop Use

A surge tank on top of the press serves as a reservoir for slack water which fills the pressure cylinder when the ram rapidly descends to the work. Rapid movement of the ram is produced through a rack and pinion drive by turning a spoked handwheel. A feature of the press is the hydraulic hoist with which it is equipped. This hoist is operated by the pump, and its movement is controlled by a single valve. It will lift parts up to one ton in weight, and is so mounted that work can be swung into the exact center of the pressure bed from the floor adjacent to the machine. This press has been found particularly useful in railroad shops for bushing work and straightening locomotive side-rods, and in malleable iron and steel foundries, for straightening castings.

LITTELL STOCK TABLE AND OILER

A combination stock table and oiler, which is intended to be used in conjunction with power presses, has just been placed on the market by the F. J. Littell Machine Co., 4125 Ravenswood Ave., Chicago, Ill. The outfit is adjustable in height to suit the press with which it is to be used, and it can be inclined to any angle. On account of the heavy base, the table need not be bolted to the floor, and so the equipment can be easily moved from one press to another.

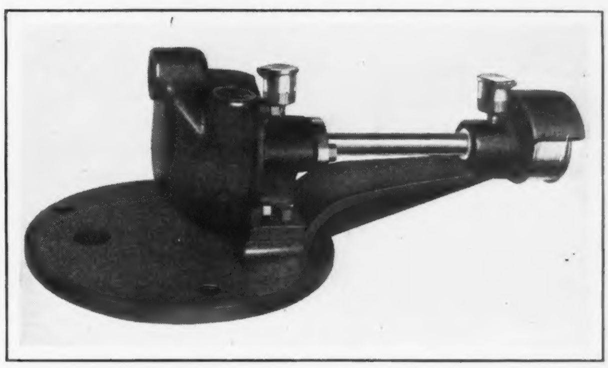


Littell Stock Table and Oiling Device for Power Presses

The oiling attachment oils the stock on the top and bottom as it is drawn across the table. It is claimed that actual experience has shown that dies can be run from two to three times longer without sharpening when the stock is oiled on both sides, than when the stock is oiled on one side only. Obviously, the oiling device saves the time required for applying oil to the stock with a brush.

ROSS CENTRIFUGAL COOLANT PUMP

A gearless centrifugal pump intended for mounting on top of Brown & Sharpe Nos. 10 and 11 grinding machines for delivering coolant to the work, has been developed by the Ross Mfg. Co., Cleveland, Ohio. The elimination of cleaning



Ross Coolant Pump for B & S Grinding Machines

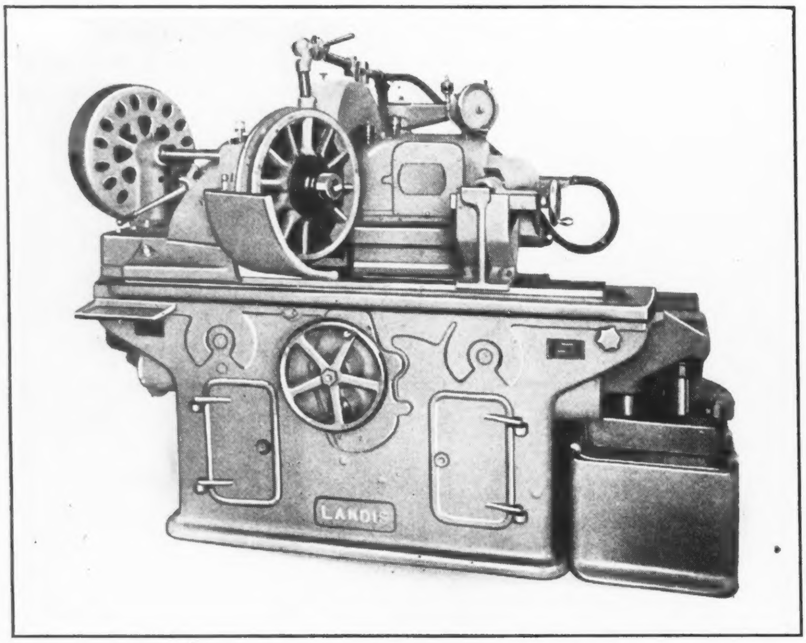


Fig. 1. Landis Brake-drum Grinding Machine with Wheel in Place

or priming, a sustained pumping capacity, and a long life are the advantages claimed for this pump, due to the appliance being operated outside of the fluid. A cast-iron bracket supports an impeller shaft which turns in bronze bearings and is driven by the belt on the cone pulley of the machine. The bearings are lubricated by oil-cups, one of the bearings being of a gland type that seals the pump chamber. The impeller is provided with four curved vanes. The liquid is taken from the tank at a point about 6 inches above the bottom, which is sufficiently high above the level of the sediment to insure practically a grit-free flow of coolant.

LANDIS BRAKE-DRUM GRINDER

A machine equipped especially for grinding automobile brake-drums is built by the Landis Tool Co., Waynesboro, Pa. This machine may be arranged for grinding either external or internal brake-drums of sizes used on all types of automobiles. Fig. 1 shows the machine with the wheel mounted in place on the holding fixture in position for grinding. Since the drum face extends under the rim of the wheel, the headstock is thrown at an angle to permit the grinding wheel to clear the rim. The grinding wheel is dressed off at an angle to correspond with the angular setting of the headstock, by means of the profile truing fixture shown on the machine.

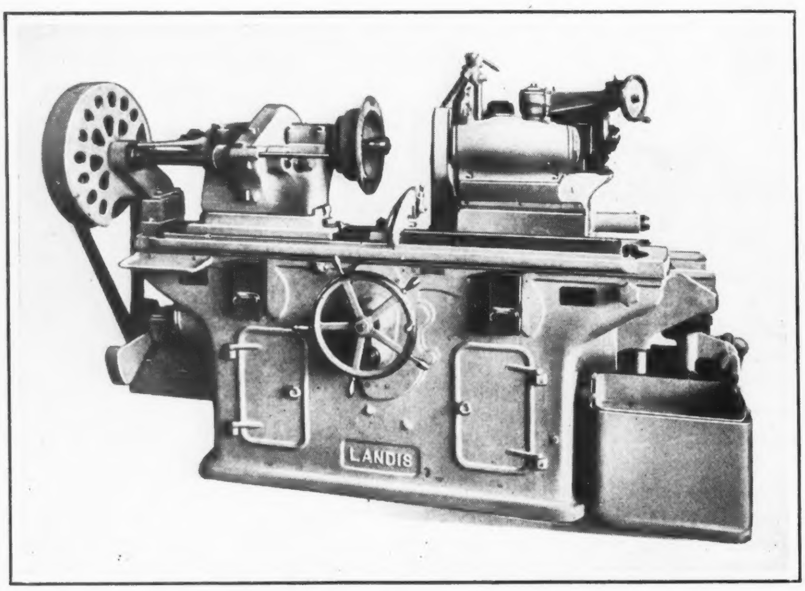
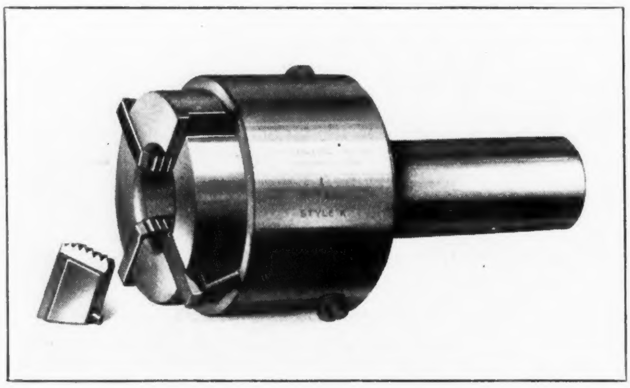


Fig. 2. Brake-drum Grinding Machine arranged for Internal Grinding

Fig. 2 shows a view of the machine arranged for internal grinding operations. To dispense with a cup grinding wheel, the grinding wheel head is again placed at an angle and the grinding wheel dressed off at an angle. The grinding wheel head is a self-contained unit with an individual motor drive, there being another motor for driving the work. The 10-inch diameter grinding wheel with which the machine is equipped is rigidly mounted on a heavy spindle. It operates on the back of the hole being ground, and rotates in such a direction that all grindings are directed downward into the water channel. As the machine is arranged for one particular size and type of drum, constant-speed motors are used and speed-changing mechanism is unnecessary.

GEOMETRIC ROTARY DIE-HEAD

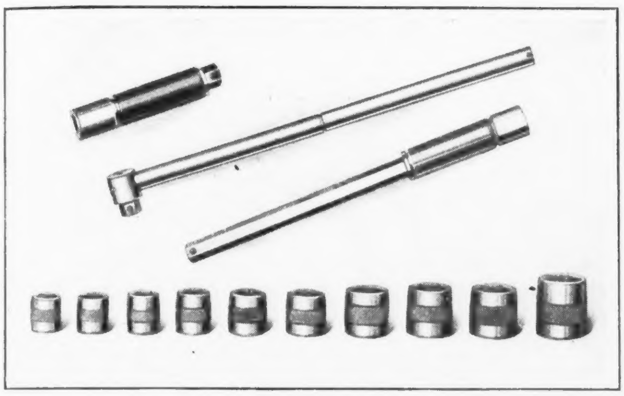
A style K self-opening die-head intended for use on all types of multiple-spindle automatic screw machines or other machines where it is necessary for the die-head to rotate, is manufactured by the Geometric Tool Co., New Haven, Conn. This die-head is carried in stock in 9/16-, 1-, 1 1/4-, and 1 1/2-inch sizes, but it is also made in larger sizes. The



Geometric Self-opening Die-head for Use on Automatic Screw Machines

smallest die-head cuts threads from 1/8 inch up to the rated size, and the largest size, from 5/8 inch up to 1 1/2 inches. The tool is made small in diameter so that it can swing freely in the limited space afforded by many automatic screw machines. There are only three units in the device, and these are completely enclosed so as to eliminate all chance of dirt or chips getting into the mechanism. Adjustment for diameter is quickly accomplished by means of a ring.

Opening and closing of the die-head is accomplished automatically with a forward and return movement. When the spindle has been advanced to a point where the desired length of thread has been cut, a stop provided on the machine comes in contact with the trip on the outside of the die-head and opens the head. When the spindle is returned, the die-head is closed by a yoke on the machine that comes in contact with the rear of the closing sleeve. The chasers project beyond the face of the die-head in such a way as to permit cutting threads close to a shoulder without making any adjustment. In the cutting position, the chasers are rigidly supported on all sides and on top, as they are completely boxed in except on the face where the teeth are located. Chasers for cutting either left-hand or right-hand threads can be used.



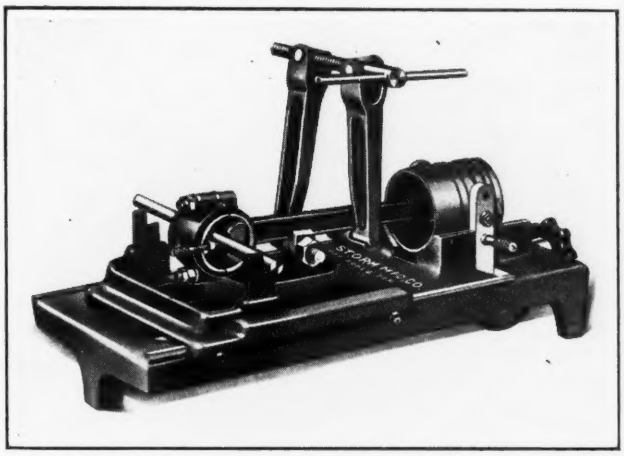
"Husky" Interchangeable-socket Wrench Set

INTERCHANGEABLE-SOCKET WRENCHES

Interchangeable-socket wrenches of a heavy-duty type have been added to the line manufactured by the Husky Wrench Co., 928 Sixteenth Ave., Milwaukee, Wis. A set of these new wrenches comprises ten sockets ranging from 5/16 to 1 5/8 inches, inclusive, in size, a combination T-handle, a "Handy" grip, and a swivel extension. The handle units permit 120 wrench combinations, such as offset, sliding T, L-type and speed wrenches. All parts are made from solid bar stock, hardened and nickel-plated.

STORM CONNECTING-ROD AND PISTON ALIGNER

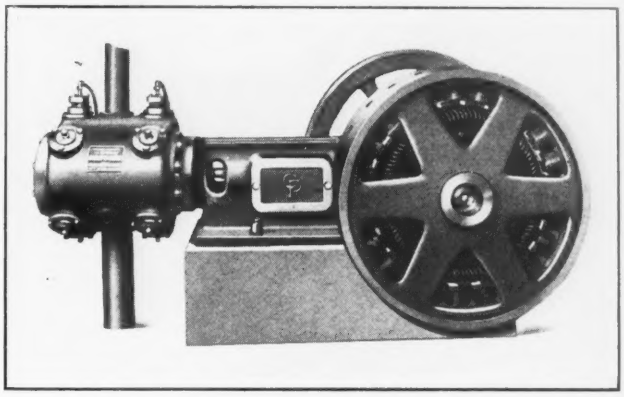
Alignment of an automobile piston and wrist-pin with the connecting-rod bearing can be accomplished by means of a device made by the Storm Mfg. Co., 406 Sixth Ave., S., Minneapolis, Minn. This device is universal in that it can be used with the parts of any automobile. It provides a means of checking a twist or bend in a connecting-rod in one operation, either with the piston attached to the rod or removed. An adjustable tool-steel bar is used, which is quickly adjustable to all sized bearings, including those that are under size and those that are over size. This bar eliminates the necessity of adjusting the connecting-rod bolts or removing shims. A gage shows where corrections are to be made, and special tools are provided to quickly bend or twist the rod into alignment. The strain of straightening the rod is not applied to the jig itself, but to the tools, and thus there is no chance of springing the main fixture.



Fixture for aligning the Piston and Wrist-pin with the Bearing of an Automobile Connecting-rod

MOTOR-DRIVEN AIR COMPRESSORS

Air compressors driven by direct-connected synchronous motors of the flywheel type are being built by the Chicago Pneumatic Tool Co., 6 E. 44th St., New York City, in sizes which have a displacement ranging from 139 to 1000 cubic feet. This flywheel type of motor is designed with the rotating element outside of the stator, and the stator is mounted in a cradle support bolted to the compressor frame. The cradle support is bored concentric with the compressor bearing so as to insure alignment of the stator and a uniform air gap when assembled. The rotor appears like an ordinary flywheel, and its face is crowned for driving an exciter or other auxiliary. The poles are mounted on the inner surface of the rim.

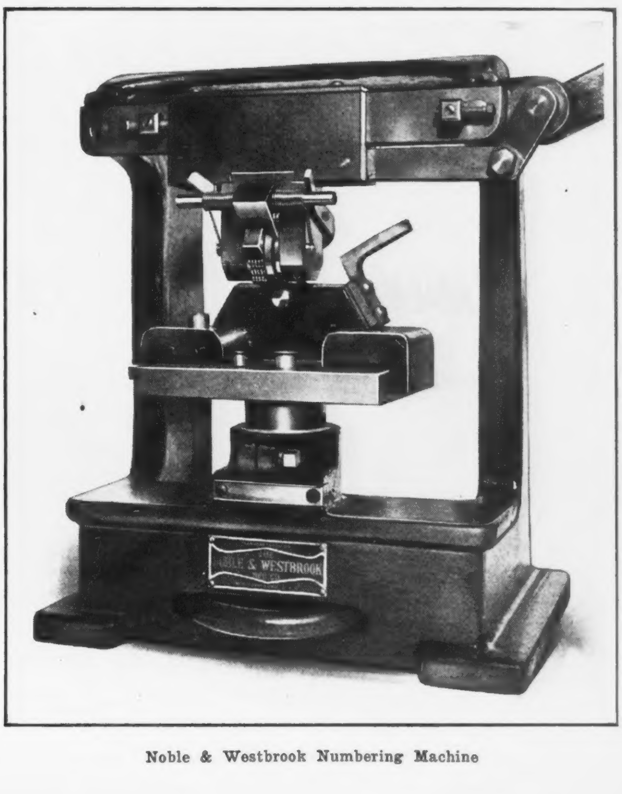


Chicago Pneumatic Compressor driven by a Flywheel Type Synchronous Motor

The air gap in this motor is relatively small, but it is kept uniform because the stator is designed so that the magnetic pull is upward. This relieves the bearings of excessive downward pressure and gives, in effect, a floating rotor. The main bearings of the compressor are fitted with die-cast bushings which may be quickly replaced as they become worn. With the construction outlined, the weight of the motor is greatly reduced and a flywheel effect obtained that results in smooth operation.

NOBLE & WESTBROOK NUMBERING MACHINE

An automatic machine for putting a serial number on either a round or flat piece is made by the Noble & Westbrook Mfg. Co., 19 Asylum St., Hartford, Conn. This equipment is built up of a marking machine similar to that illus-



Noble & Westbrook Numbering Machine

PROFITS

The object of business is to make profits. Unless it makes profits, no business can make anything else, very long.

Profits arise only when the cost of production is below the selling price.

The use of up-to-date machinery has always been a most potent factor in keeping costs below selling prices.

In these days of high labor costs and keen competition, the poorly equipped factory is hobbled—hopelessly hobbled—in the race for profits.

How many out-of-date machines are hobbling your own business?

Take off the hobbles, and get a lead in the race, by replacing those old machines with modern

Machine Tools—The Master Tools of Industry

NATIONAL MACHINE TOOL BUILDERS' ASSOCIATION

This space contributed by
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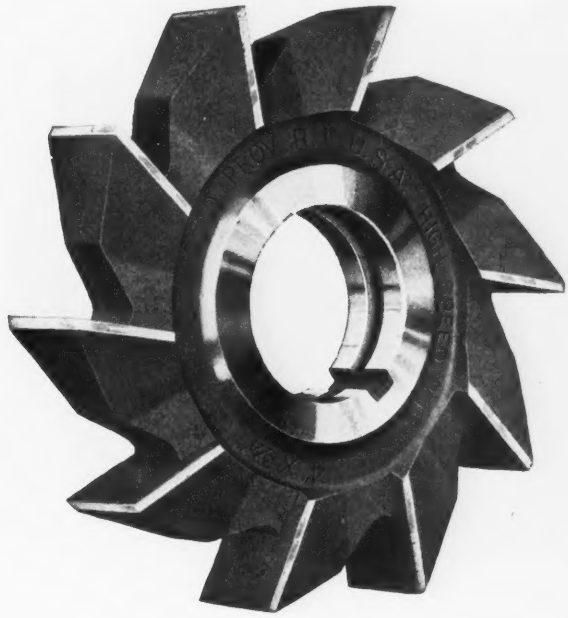
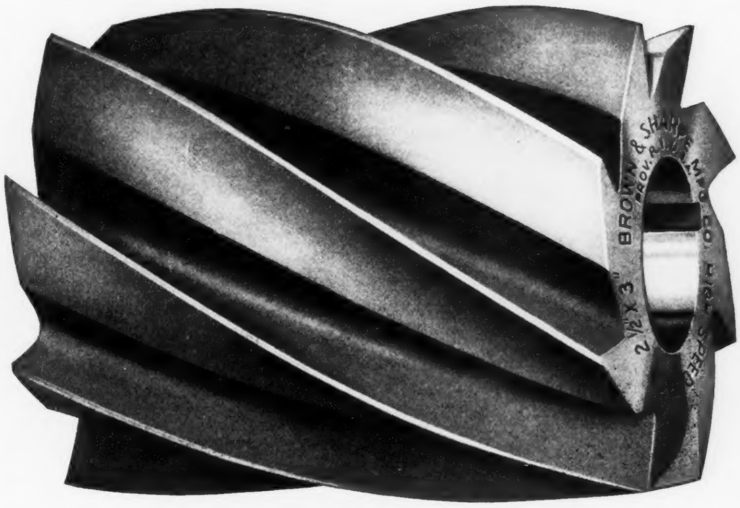
THERE IS NO SUBSTITUTE FOR "QUALITY"





It pays to buy Brown & Sharpe "Quality" Cutters—

. . . . . with an experience behind them of over 60 years as cutter manufacturers and users.

BROWN & SHARPE MFG. CO.
Providence, R. I., U. S. A.

BROWN & SHARPE CUTTERS

trated in October, 1922, MACHINERY, and a numbering device similar to that shown in September, 1924, MACHINERY. The automatic numbering head is usually employed in a press to number flat surfaces serially and is not a new operation, but the numbering of round parts serially is not so common.

The machine is equipped with a mandrel for holding the work and a special tripping device that operates the numbering unit automatically. The wheels of this unit have hand engraved figures, and they are tempered to withstand hard use. Correct temper of the parts is insured by checking with a hardness tester. This marking machine weighs about 60 pounds, and is operated by a hand-lever. Roller bearings are provided for the slide, and the table is adjustable for height.

BARKER-STATE UNIVERSAL SAW

A gear-driven saw intended for cutting wood, metal, bakelite, and a large variety of compositions, has recently been brought out by R. L. Barker & Co., 642 W. Washington Blvd.,

Barker-State Saw designed for cutting Metal, Wood, and Compositions

Chicago, Ill. The saw is driven by a ½-horsepower motor through helical gears which run in oil. Ball bearings of large size are provided for the shafts in the drive. The power unit is operated up and down by means of a handwheel adjustment. The table measures 23 by 28 inches and accommodates stock up to 12 inches wide. The saw is 8 inches in diameter and will take a cut up to 2⅜ inches deep. A removable 1-inch dado plate is furnished. The shipping weight of this equipment is about 300 pounds.

* * *

A textile machinery meeting was held at Lowell, Mass., Monday, March 30, under the auspices of the Boston Local Section of the American Society of Mechanical Engineers and the Textile Section of the society. The program included an inspection visit to the Saco-Lowell Shops and addresses by C. M. Eames, president of the Lowell Textile School, O. P. Greenwood, superintendent of the Saco-Lowell Shops, and Professor S. Smith of the Cotton Department of the Lowell Textile School.

NEW MACHINERY AND TOOLS NOTES

V-blocks and Clamp: Brown & Sharpe Mfg. Co., Providence, R. I. A set of V-blocks with clamp, having 1/2 inch greater capacity than those previously manufactured by the company, and designed to fill the demand for an inexpensive set of V-blocks and clamp for general machine shop use.

Steel Hearth: Buffalo Forge Co., 144 Mortimer St., Buffalo, N. Y. A new No. 236 one-piece steel repair hearth about 6 inches deep and 24 by 24 inches square. The advantages claimed for this one-piece steel hearth are strength, absence of cracks or seams that collect moisture, and elimination of rust. The hearth is equipped with heavy braced angle-iron legs, blower, steel hood, cast-iron fire pot, etc., and weighs about 180 pounds.

Lubrication System: Century Electric Co., 1827 Pine St., St. Louis, Mo. A method of lubricating fractional-horsepower motors by a wool-yarn system. Continuous strands of wool yarn are packed into an oil-well in direct contact with the armature shaft. Constant contact is insured by a spring attached to the under side of the oil-well cover, which exerts a downward pressure against the wool. As wool yarn has a high capillary action, a large amount of lubricant is absorbed by the yarn and held in suspension for lubricating the armature shaft. In addition to the oil held in the yarn, there is, of course, an additional supply in the oil-well.

Wire Rope and Fittings: American Cable Co., 105 Hudson St., New York City. Wire rope made up of wires and strands that are "preformed" to the shape they must have to fit correctly into the completed product. This "Tru-lay" rope is made in Lang and regular lays up to 1 inch in diameter. It can be cut at any point for splicing without the necessity of "seizing," as one characteristic of the rope is its resistance to unstranding. Special steel fittings are also made for use with this rope. They permit the use of turnbuckles, shackles, etc. A steel sleeve is slipped over the smooth unseized end of the rope, placed in a press, and fastened on the wire rope. This sleeve is made in various lengths, and can be threaded, equipped with heads of various types for wrenches, or furnished with eyes or hooks.

Baling Press: Hydraulic Press Mfg. Co., Mount Gilead, Ohio. A horizontal machine for compressing steel scrap up to 1/16 inch thick into bales measuring 10 by 10 by 16 inches and weighing about 115 pounds. The press is so designed that it can be located on the floor or in a comparatively shallow pit with the top of the baling box at the floor level. Two rams operate horizontally. Heavy steel castings are used for the side, ends, and bottom of the baling box, and they are secured to each other by tie-rods and dovetail joints. Mounted on top of each high-pressure hydraulic cylinder is a low-pressure cylinder which is connected to air pressure or low water pressure to cause the main hydraulic cylinders to return to the initial position. Pressure for the main hydraulic rams is supplied by a high- and low-pressure pump.

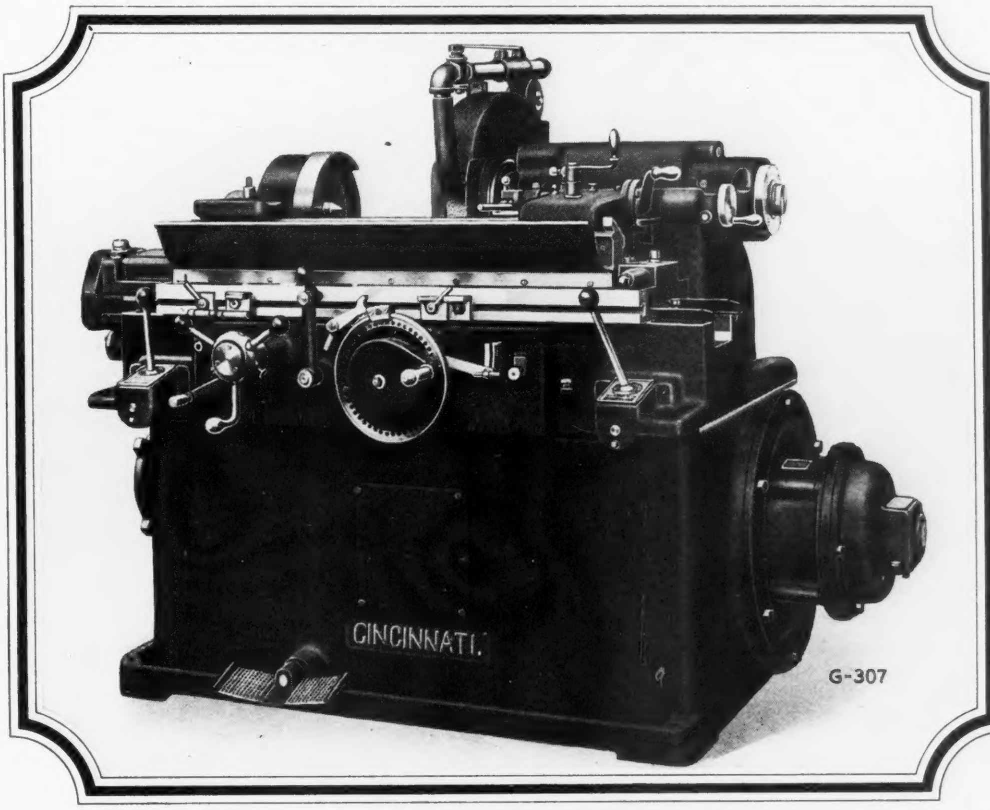
* * *

ANNUAL MEETING OF WELDING ENGINEERS

The American Welding Society will hold its annual meeting at the Engineering Societies' Building, 29 W. 39th St., New York City, April 22 to 24. The first day will be devoted entirely to committee meetings, committees on resistance welding, gas welding, electric arc welding, and education meeting on that day. The second day will be devoted to a business session and to an inspection trip to the Bay Way Plant of the Standard Oil Co. The annual dinner will be held in the evening of the second day. The third day will be devoted to technical sessions covering methods of inspecting welds and the testing of the skill of operators.

* * *

In 1921 there were 967 makers of horse-drawn vehicles in the United States. This number fell to 493 in 1923.



NEW! 8 INCH SADDLE TYPE SELF-CONTAINED CYLINDRICAL GRINDER

A new development in cylindrical grinding machines is typified in the 8" Self-contained Saddle Type Grinder shown above. The spindle is mounted solidly in the bed and a saddle carrying the work centers, moves in and out, giving greater rigidity, smoother cuts, more accurate sizing and more metal removal. New ideas—new methods—new applications of grinding principles have been incorporated in our complete line of Cincinnati Grinders.

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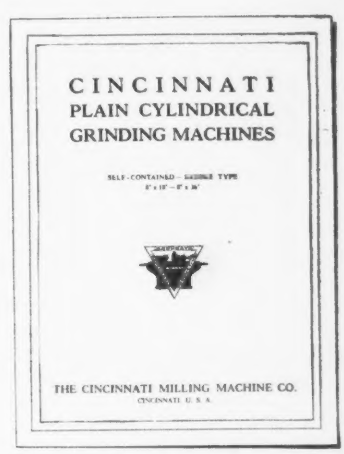
THE CINCINNATI GRINDER CO. CINCINNATI, OHIO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PLAIN CYLINDRICAL
GRINDING MACHINES

THE CINCINNATI MILLING MACHINE CO.

Send today for this special circular fully describing the new 8" Self-contained Saddle Type Grinder.

CINCINNATI GRINDERS

TRADE NOTES

NATIONAL MFG. Co., Sterling, Ill., maker of builders' hardware, has recently awarded the Austin Co., of Cleveland, Ohio, a contract for the design and construction of a new five-story factory building.

CARPENTER STEEL Co., Reading, Pa., has removed its office and warehouse in Cleveland, Ohio, to 1515 Hamilton Ave., where a complete stock of high-speed steel, carbon tool steel, and drill rods will be carried.

LANDIS MACHINE Co., INC., Waynesboro, Pa., manufacturer of thread-cutting die-heads and thread-cutting machinery, has opened an office in Detroit at 5928 Second Blvd., of which J. W. Frey is in charge.

SIMONDS SAW & STEEL Co., New York City, has combined its sales office and service station at 109 Lafayette St. A large stock of standard size circular and band saws and machine knives will be carried at this office.

YOST MFG. Co., Meadville, Pa., manufacturer of vises, anvils, and gas soldering furnaces, has opened a Chicago office and warehouse at 25 S. Jefferson St., with H. S. Huncke in charge. A complete stock will be maintained at the Chicago office.

FOOTE BROS. GEAR & MACHINE Co., 232-242 N. Curtis St., Chicago, Ill., has recently completed arrangements with Gibbens & Gordon, 532 Canal St., New Orleans, La., for the distribution of Foote IXL speed reducers and gear products in the New Orleans territory.

DIEFFENBACH WESTENDORF MFG. Co., 109 S. Calvert St., Baltimore, Md., has changed its firm name, due to a change in personnel, to DEMCO INC. The word "Demco" was adopted to designate the activities of the company, namely, designing, engineering, and machinery manufacturing.

GIBB WELDING MACHINES Co., Bay City, Mich., (successor to the Gibb Instrument Co.), has appointed the Welding Service & Sales Co., Donovan Bldg., Detroit, Mich., agent in the Detroit territory for its line of arc, spot, and steam welding machines. T. M. Butler is manager of the Welding Service & Sales Co.

CARROLL & JAMIESON MACHINE TOOL Co., 253 Davis Ave., Batavia, Ohio, has purchased the complete equipment for manufacturing the "Advance" engine lathes formerly made by the Universal Machinery Co., of Milwaukee, Wis., and is now in a position to supply repair parts and attachments for these lathes.

HALL PLANETARY THREAD MILLING MACHINE Co., INC., Bridesburg, Philadelphia, Pa., has broken ground for the erection of a new and larger shop on the 3½-acre plot recently procured by the company at Fox St. and Abbottsford Ave. The plant is to be of full glass construction, and will be ready for occupancy about June 1.

HILL CLUTCH MACHINE & FOUNDRY Co., Cleveland, Ohio, has recently appointed T. L. Rose & Son, 901 House Bldg., Pittsburg, Pa., as its representative in Pittsburg and the adjacent territory for the sale of Hill friction clutches, collar oiling bearings, spur gear speed transformers, automatic belt tighteners, and agitator equipment.

STOW MFG. Co., INC., Binghamton, N. Y., has appointed the Horne Co., Ltd., 36 Kawaguchi-Cho, Nishi-Ku, Osaka, Japan, agent throughout Japan, as well as Korea, Formosa and Manchuria, for the sale of the company's line of flexible shafts, grinders, drills, railroad track grinders, taximeter and speedometer cores, and similar products.

ELECTRIC ARC CUTTING & WELDING Co., 152 Jelliff Ave., Newark, N. J., has opened a new branch office at Syracuse, N. Y., which is completely equipped to handle all sales and distribution of welding machines and supplies for the entire state, exclusive of the metropolitan district. The new branch office will be under the supervision of William P. McCarthy.

E. L. ESSLEY MACHINERY Co., 551 W. Washington Blvd., Chicago, Ill., has recently been appointed exclusive selling agent throughout the Chicago territory for the full line of high-speed riveting hammers manufactured by the High Speed Hammer Co., of Rochester, N. Y., as well as for the broaching machines made by the J. N. Lapointe Co., of New London, Conn.

RICH TOOL Co., Detroit, Mich., manufacturer of valves and rivet sets, has consolidated its offices, the executive, sales, engineering, treasury, and accounting departments now being located at the plant offices at 1501 Ferry Ave., E. The offices formerly located in the Railway Exchange Building, Chicago, Ill., and the Donovan Building, Detroit, Mich., have been discontinued.

PRATT & WHITNEY Co., Hartford, Conn., recently held its annual banquet, at which eighty-four employes who have served the company for twenty-five years or more were entertained. The two oldest empl yes, F. W. Woodworth and J. F. Coffey, have been associated with the company for fifty-seven years. Each of the employes was presented with a blue and gold button on which was the inscription "P & W —Quarter Century Service."

OESTERLEIN MACHINE Co., Cincinnati, Ohio, has acquired the line of drilling machines formerly manufactured by the AURORA TOOL WORKS, Aurora, Ind., including all jigs, fixtures, patterns, inventory of parts, and raw materials, as well as patents and good will. The Oesterlein Machine Co., will continue to build the Aurora line of upright drill presses from 20 to 44 inches inclusive, and also the new high-power ball bearing upright drills developed by the Aurora Tool Works. The business will be conducted as a division of the Oesterlein Machine Co., and all manufacturing will be handled in the company's plant at Cincinnati.

* * *

PERSONALS

ALFRED L. LOVEJOY has resigned as New York sales manager of the Pratt & Whitney Co., Hartford, Conn., owing to ill health.

ARTHUR W. WIESE has been appointed manager of the Philadelphia office of the Strom Ball Bearing Mfg. Co., at 309 Lincoln Bldg.

A. S. TAYLOR, formerly sales engineer for the United Alloy Steel Corporation, Canton, Ohio, is now with the Central Steel Co., of Massillon, Ohio, in the same capacity.

J. M. MCNEAL, England representative for the Landis Machine Co., Waynesboro, Pa., manufacturer of thread-cutting machines, sailed on the *Olympic* March 7 for London.

CHARLES A. SWAN, who has had wide experience in the production and sales of electric furnace steels, has become associated with the Timken Roller Bearing Co., of Canton, Ohio, as assistant manager of steel sales.

KENNETH W. REED of Cincinnati, Ohio, has recently joined the engineering staff of the V. & O. Press Co., Hudson, N. Y. Mr. Reed was formerly assistant chief engineer of the new developments division of the American Laundry Machine Co., Cincinnati, Ohio.

PAUL C. BURTON, mechanical designer and inventor of several devices patented for the National Automatic Tool Co., of Richmond, Ind., and the Mechanical Engineering Co., of Chicago, Ill., has joined the engineering force of Foote Bros. Gear & Machine Co., 215 N. Curtis St., Chicago, Ill.

ROBERT J. O. SIMPSON, superintendent of the L. S. Starrett Co., Athol, Mass., was presented with a gold watch, suitably engraved, by his associates, in celebration of the completion of twenty-five years' service as superintendent of the company. Mr. Simpson started with the company twenty-nine years ago as foreman of the tool-room.

ERNEST W. TAYLOR was elected a member of the board of directors of the L. S. Starrett Co., Athol, Mass., at the recent annual meeting of the stockholders, to fill the vacancy caused by the death of James A. Stiles. Mr. Taylor has been connected with the company for twenty-eight years, during which time he has been in charge of credits and collections, and for the last two years has held the office of assistant treasurer.

FARRAND P. HALL has been appointed district sales manager for the Carborundum Co., Niagara Falls, N. Y., in charge of the sales organization and branch warehouse at Cleveland, Ohio. Mr. Hall succeeds JOHN MACARTHUR, who has been district sales manager at Cleveland for the last five years. Mr. MacArthur has been assigned to special sales service work, and will be located at the main office of the company at Niagara Falls.

MATT J. HEROLD has returned to the United States Electrical Tool Co., Cincinnati, Ohio, as general sales manager. Mr. Herold entered the employ of the company over twenty years ago. In 1909 he began traveling for the company, but left the following year to become associated with a large steel manufacturer. In 1922 he was placed in charge of the East Central division of sales for the Wood-Imes Mfg. Co., of Minneapolis, which position he has now left to return to the United States Electrical Tool Co.

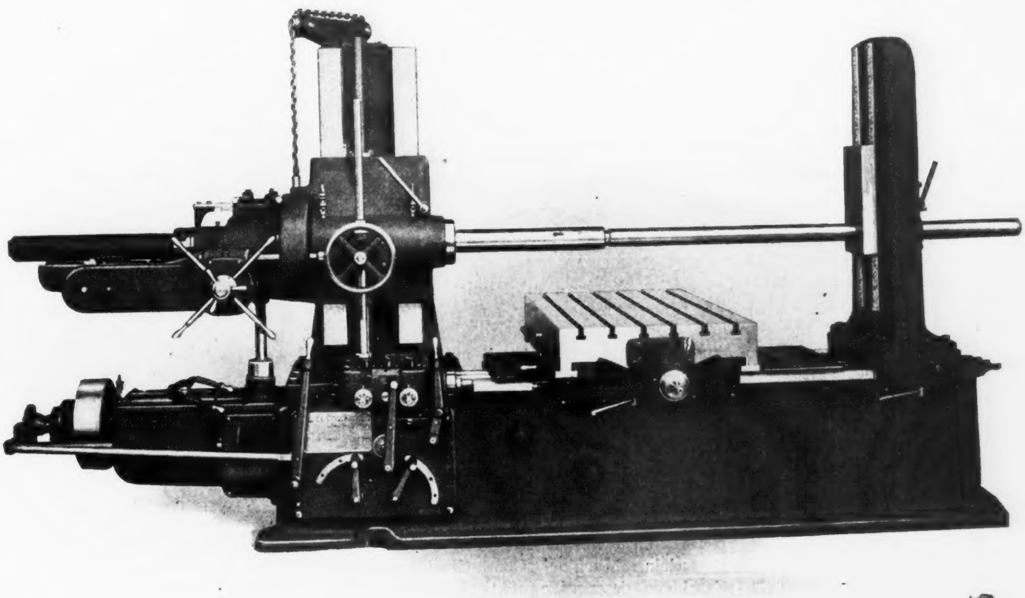
W. F. SCULLY, formerly president of the Advance Furnace & Engineering Co., of Springfield, Mass., has rejoined the organization of the Gilbert & Barker Mfg. Co., as manager of furnace and factory sales. Mr. Scully was connected with the Gilbert & Barker Mfg. Co., from 1910 to 1920, leaving in the latter year to organize the Advance Furnace & Engineering Co. The patents, patterns, records, etc., of the latter company have been purchased by the Gilbert & Barker Mfg. Co., who will be in a position to supply repair parts for Advance equipment.

Honorable Competition is a good thing because it is a factor in Progress

A number of our customers inform us that they have obtained complete contracts, providing work for their entire equipment, because they have a LUCAS

"PRECISION"

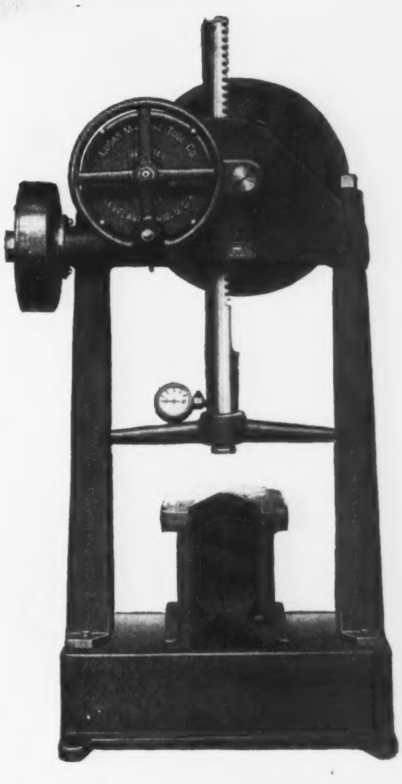
Horizontal Boring, Drilling and Milling Machine



Replace the sledge hammer for drive fit work. It can't compete with the

LUCAS Power Forcing Press

The belt does the work and saves the workman's time and energy for better use.



THE LUCAS MACHINE TOOL CO.

NOW AND ALWAYS OF

CLEVELAND, OHIO, U. S. A.

FOREIGN AGENTS: Alfred Herbert, Ltd., Coventry. Societe Anonyme Belge, Alfred Herbert, Brussels. Allied Machinery Co., Turin, Barcelona, Zurich. V. Lowener, Copenhagen, Christiania, Stockholm. R. S. Stokvis & Zonen, Paris and Rotterdam. Andrews & George Co., Tokyo.

COMING EVENTS

APRIL 22—Twenty-seventh convention of the National Metal Trades Association in Cleveland, Ohio; headquarters, Hotel Cleveland. National secretary, J. E. Nyhan, Peoples Gas Bldg., Chicago, Ill.

APRIL 22-24—Annual meeting of the American Welding Society at the Engineering Societies' Bldg., 29 W. 39th St., New York City.

MAY 5-7—Joint convention of the Southern Supply and Machinery Dealers' Association and the American Supply and Machinery Manufacturers' Association in Atlanta, Ga.; headquarters, Atlanta-Biltmore Hotel. Secretary-treasurer, F. D. Mitchell, 1819 Broadway, New York City.

MAY 6-8—National convention of the Society of Industrial Engineers in Cleveland, Ohio; headquarters, Hotel Winton. Executive secretary, George C. Dent, 608 S. Dearborn St., Chicago, Ill.

MAY 7-9—Ninth annual meeting of the American Gear Manufacturers' Association at the William Penn Hotel, Pittsburg, Pa. T. W. Owen, secretary, 2443 Prospect Ave., Cleveland, Ohio.

MAY 11-23—Southern Exposition to be held at Grand Central Palace, New York City. Further information may be obtained from William G. Sirrine, Greenville, S. C., or the Merchants' Association of New York, 233 Broadway, New York.

MAY 18-21—Spring meeting of the American Society of Mechanical Engineers in Milwaukee, Wis. Secretary, Calvin W. Rice, 29 W. 39th St., New York City.

MAY 28-30—Spring sectional meeting of the American Society for Steel Treating in Schenectady, N. Y.; headquarters, Hotel Van Curler. Secretary, W. H. Eisenman, 4600 Prospect Ave., Cleveland, Ohio.

JUNE 16-19—Summer meeting of the Society of Automotive Engineers at Greenbrier Hotel, White Sulphur Springs, W. Va. Secretary, Coker F. Clarkson, 29 W. 39th St., New York City.

JUNE 22-26—Annual meeting of the American Society for Testing Materials at Chalfonte-Haddon Hall, Atlantic City, N. J. Secretary-Treasurer, C. L. Warwick, Engineers' Club Building, 1315 Spruce St., Philadelphia, Pa.

JUNE 24-26 — Twelfth National Foreign Trade Convention in Seattle, Wash. Secretary of the National Foreign Trade Council, O. K. Davis, India House, Hanover Square, New York City.

SEPTEMBER 8-11—Machine Tool Exhibition in the Mason Laboratory, Sheffield Scientific School, Yale University, New Haven, Conn. H. R. Westcott, chairman, 400 Temple St., New Haven, Conn.

SEPTEMBER 14-18—Annual convention of the American Society for Steel Treating, and Seventh National Steel Exposition, to be held at the Public Auditorium, Cleveland, Ohio. Secretary, W. H. Eisenman, 4600 Prospect Ave., Cleveland, Ohio.

OCTOBER 5-9—Annual convention of the American Foundrymen's Association at Syracuse, N. Y. An exhibition of foundry and machine shop equipment and supplies will be held in connection with the convention.

NEW CATALOGUES AND CIRCULARS

RIVETERS. Hanna Engineering Works, 1763 Elston Ave., Chicago, Ill. Bulletin R-201, containing specifications covering Hanna "Pinch Bug" riveters.

FORGES. Buffalo Forge Co., 144 Mortimer St., Buffalo, N. Y. Circulars illustrating the various styles of pressed-steel forges manufactured by this concern.

FANS. Wagner Electric Corporation, St. Louis, Mo. Bulletin 143, containing sales information and specifications for the line of electric fans produced by this company.

OVER-CURRENT RELAYS. General Electric Co., Schenectady, N. Y. Bulletin 47640.2, descriptive of four forms of induction time over-current relays, and their applications.

BALL BEARINGS. New Departure Mfg. Co., Bristol, Conn. Circular illustrating and describing the installation of New Departure ball bearings in an automatic knife handle machine.

ELECTRIC TOOLS. Hisey-Wolf Machine Co., Cincinnati, Ohio. Price list No. 30, effective February 16, giving reduced prices on Hisey electric drills, screwdrivers, buffing lathes and grinders.

FANS AND BLOWERS. American Blower Co., Detroit, Mich. Bulletin 1801, illustrating and describing American "Sirocco" fans and blowers. Leaflet descriptive of the ABC air washing and cooling fan.

BALL BEARINGS. Strom Ball Bearing Mfg. Co., 4563 Palmer St., Chicago, Ill. Pamphlet covering the design, dimensions, materials, workmanship, and load-carrying capacities of the "Super-Strom" ball bearings.

MILLING MACHINE. Ingersoll Milling Machine Co., 2442 Douglas St., Rockford, Ill. Circular illustrating Ingersoll adjustable rail milling machines of the planer type, as well as some standard Ingersoll inserted-tooth milling cutters.

HOISTS. Motorbloc Corporation, Summerdale, Philadelphia, Pa. Bulletin L-55, containing instructions for maintaining and operating the "Motorbloc" chain hoist. A general description, oiling directions, and list of parts are included.

GRINDING AND MIXING MILLS. Hardinge Co., Yorke, Pa. Bulletins 18 and 19, describing, respectively, fine grinding with tube mills of the conical tube type, and grinding and mixing with batch mills of the cylindrical and conical types.

ELECTRIC GRINDERS AND BUFFERS. Hisey-Wolf Machine Co., Cincinnati, Ohio. Bulletin 1582, descriptive of Hisey combination grinders and buffers, which are made in 1/2 and 1 horsepower sizes, with open and encased spindle extensions.

MILLING MACHINES AND GRINDERS. Oesterlein Machine Co., Cincinnati, Ohio. Catalogue descriptive of the alignment limits and testing methods used in building Ohio milling machines, Ohio grinders, and the Ohio tilted rotary milling machine.

DRILLING MACHINES. Fosdick Machine Tool Co., Cincinnati, Ohio. Pamphlet illustrating and describing in detail Fosdick high-speed ball-bearing sensitive drills, with spiral gear drive, which are built in combinations of from one to six spindles.

BRASS AND COPPER TUBES. Bridgeport Brass Co., Bridgeport, Conn. Data Book No. 16, containing prices and weights of sheet brass, brass rod, wire, condenser tubes, and seamless brass and copper tubes. Copies may be obtained by those interested upon request.

GRINDING AND POLISHING MACHINERY. Cleveland Armature Works, Inc., 4732 St. Clair Ave., Cleveland, Ohio. Catalogue 315 and bulletin 600, describing the entire line of direct and chain-driven grinding, buffing, and polishing machines made by this company.

SAWS. National Twist Drill & Tool Co., Detroit, Mich. Circular intended to assist users in the proper use of saws for slitting or cutting operations. Besides the regular metal slitting saw, two new types of saws are shown, and the work for which each type is best suited is indicated.

GRINDING WHEELS. Norton Co., Worcester, Mass. Pamphlet treating of the balancing of grinding wheels, discussing the advantages of balancing, balancing economy, and equipment for balancing. Information is also given on balancing for precision grinding, and balancing off-hand wheels.

SMALL TOOLS. Gairing Tool Co., Inc., Detroit, Mich. Catalogue 18, containing illustrations and price lists, covering the line of tools made by this concern, which includes counterbores and holders, countersinks, core drill holders and cutters, spot facing tools, grinding fixtures, universal fixtures, etc.

BELTING. W. A. Jones Foundry & Machine Co., 4409 W. Roosevelt Road, Chicago, Ill. (agent for the Victor Balata & Textile Belting Co., 38 Murray St., New York City). Circular outlining some of the distinctive features of "Ampere" canvas stitched belting for transmission and elevator or conveyor work.

UNIVERSAL TURRET LATHES. Warner & Swasey Co., Cleveland, Ohio. Pamphlet entitled "Profits from Small Lot Production," showing the possibilities of using turret lathes for small lots, such as from five to fifteen pieces of a kind. Set-ups for different jobs are illustrated, and the actual time is given in each case.

ELECTRIC MEASURING INSTRUMENTS. Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa. Bulletin 533, illustrating and describing the Burrows permeameter and the Epstein core loss apparatus. Bulletin 984, descriptive of the Vreeland oscillator and other devices for producing high-frequency alternating current.

FLEXIBLE COUPLINGS. Falk Corporation, Milwaukee, Wis. Bulletin 35, descriptive of Falk-Bibby flexible couplings, which have capacities ranging from 1/3 to 20,000 horsepower at 100 revolutions per minute. Actual examples are given to illustrate the method of selecting the correct type of coupling for a given class of work.

CENTRIFUGAL PUMPS. Goulds Mfg. Co., Seneca Falls, N. Y. Pamphlet containing the report of an investigation of the performance of centrifugal pumps when pumping oils. The investigation was conducted for the Goulds Mfg. Co., by Robert L. Dougherty, professor of mechanical and hydraulic engineering of the California Institute of Technology, in collaboration with the Union Oil Co. of California. The performance is graphically shown by means of charts.

PRESSES. Hamilton Press & Machinery Co., 516 Marquette Bldg., Detroit, Mich. Circular illustrating what is said to be the largest double-crank press ever built. An idea of the size of the press is conveyed by the picture on the front cover which shows twelve men seated on the bed between the housings. The press is used for blanking, piercing and forming the side rails for automobile frames, and the design is also especially suitable for railroad car shops.

GEARS. Meisselbach-Catucci Mfg. Co., 54 Stanton St., Newark, N. J., has brought out a small gear handbook containing some valuable data on gears, including a table of tooth dimensions for diametral pitches from 1/2 to 200, and tables giving the pitch diameter and outside diameter of gears of different numbers of teeth, varying in diametral pitch from 14 to 200. The illustrations give an idea of the wide variety of small precision gears and parts produced by this concern, and M-C spur and spiral gear-hobbing machines are also shown.

PRECISION GAGES. C. E. Johansson, Inc., Division of Ford Motor Co., Poughkeepsie, N. Y. Catalogue illustrating and describing Johansson precision gages. The book tells what these gage-blocks are, how they are used, and in what combinations they can be obtained. Typical applications are illustrated, and complete data are given, including prices for the various sets. The catalogue also contains sections giving information on the details of construction and use of Johansson adjustable limit snap gages and Johansson tolerance plug gages.